TOPICS OF THE MONTH

Changing picture in the European chemical industry

ALTHOUGH the general trend towards the slowing down in the rate of economic expansion has affected the chemical industry to a certain extent also, it is still continuing to increase its importance compared with the other industrial sectors. In general, the increase in world demand for chemicals and the launching every year of new products on the market, creating a further demand, seem to ensure a relatively high rate of expansion for the chemical industry provided that there is no fundamental change in economic and political conditions.

These are two of the conclusions drawn in the latest O.E.E.C. survey* of the European chemical industry, covering 1956 and the first half of 1957, which reveals that, with an increase of 8% in production compared with the previous year, the output of the industry in O.E.E.C. countries continued to expand in 1956 and the rate of increase was again higher than that of total industrial production. It seems that the rate of investment will remain high in the near future. For example, it is expected that $660 million will have been invested in the petroleum chemicals industry alone between January 1957 and the end of 1959. In the nitrogenous fertilisers industry an expansion of about 15% in production capacity between 1957 and 1959 is forecast. For other sectors, the figures are not known, but it is certain that substantial investment will be necessary to increase production, modernise and rationalise existing plant and manufacture new products (*e.g.* synthetic rubber).

In the inorganic chemical industry, production seems to have increased at a slower rate than during the previous years, judging from the index of certain representative products. For instance, production of soda ash increased by about 3% only in 1956 compared with 6% in the previous year. Production of chlorine was 6% greater than in 1955, when an increase of 12% was registered. For caustic soda, the increase on 1955 is estimated at 4%, a figure which is fairly close to that of the preceding year. Production of sulphuric acid increased by 5½%, 1% less than in 1955. Only in the case of calcium carbide was the rate of increase slightly higher than in 1955. The rate of expansion of organic chemical production probably slowed down also in relation to 1955, although here there is an even greater lack of exact and comparable figures.

In the United States, production of soda ash showed an increase of 2% in 1956, compared with 4% for the previous year. Caustic soda production there rose by 8% and, with rising demand for chlorine, there are signs of some over-production of caustic, demand on the home market being stable and exports, though increasing, providing a market for less than 10% of output. The U.S. chlorine industry is operating at virtually 100% capacity.

During the period July 1, 1956, and June 30, 1957, supply of and demand for fertilisers continued to increase, and the complex fertilisers sector continued to expand. In the nitrogen sector, the increasing surplus of production over internal demand led to a substantial rise in exports to non-member countries. In 1957-58 and 1958-59, total nitrogen production is expected to increase further by about 12% and 9% respectively. On the subject of nitrogen consumption, the O.E.E.C. report suggests that this has increased more slowly than production and the resulting surplus will have to be stocked or sold on the world market. In these circumstances, it is possible that production may not everywhere reach the level forecast.

The increasing prominence of certain sectors, such as the petroleum chemicals industry, is apparent from the survey. In Western Europe, this industry is not only continuing to expand rapidly but should, over the next few years, substantially increase its rate of expansion. From mid-1953 to the end of 1959, total investment in the industry is expected to rise from $240 million to over $1,070 million and production of petroleum chemicals (measured in terms of tonnage of carbon content) from just over 200,000 tons to over 1.2 million tons.

Taking European chemicals as a whole, there is every indication that the slower trend in expansion has been reversed, temporarily at least, for production in the first half of 1957 was 13% higher than in the first six months of 1956. This further increase in production has resulted, on the whole, in a higher use of production capacity.

**The Chemical Industry in Europe*, O.E.E.C., Paris, 1957, 18s.

Acetylene from hydrocarbons

PRODUCTION of acetylene and ethylene by the high-temperature treatment of saturated hydrocarbons is achieved in a new process developed in the United States and making use of a special furnace capable of withstanding temperatures up to 2,500°C. The Eastman process, as it is called, is claimed to have advantages over previous methods of producing acetylene from saturated hydrocarbons—such as the arc process, which requires a large amount of electrical power, the regenerative furnace, which involves cyclic operation, and the partial combustion process, which demands a relatively large amount of oxygen.

In the Eastman process, very briefly, a fuel such as natural gas is heated to 600°C. and fed to the burner where combustion takes place with either oxygen or air mixed with steam and also preheated to 600°C.

Hydrocarbon cracking feed and some low-pressure steam are heated in a third preheater and are then mixed with the products from the combustion chamber, the resulting mixture passing into the reaction zone where the dissociation of the cracking stock to form unsaturated products is completed. The products are then quickly cooled with a water spray to prevent further decomposition.

Details of the process appeared in *Chemical & Engineering News* of December 1957, according to which the interior construction material for the furnace is stabilised zirconia. It is believed that furnaces can be built to operate satisfactorily with maintenance only once a year.

Canada's big new aluminium plant

THE new aluminium smelter of the Canadian British Aluminium Co. at Baie Comeau in the Province of Quebec must be one of the fastest-built major projects on record, for it was less than 20 months after site-clearing work began that the first metal was poured. The event marked the completion of the first of four production stages of the £50-million plant which will eventually have an annual capacity of 160,000 long tons of virgin aluminium ingot.

The first stage of the smelter, like the other three stages still to come, has two furnace bays each a third of a mile long. There is a high degree of mechanisation and automatic control. The plant includes a carbon plant with some very modern features as well as a laboratory, service building, workshops and offices, together with alumina and coke silos.

Baie Comeau represents one of Britain's major investments in Canada in recent years, the operating company being a subsidiary of British Aluminium Ltd. and formed in partnership with one of Canada's largest pulp and paper companies, the Quebec North Shore Paper Co. Further details of the plant will appear in our next issue.

Carbon black in Europe

TWO of the elements which may be obtained in pure form from crude oil are sulphur and carbon. The original carbon black industry which thrived in the United States on natural gas is now extending its activities to the European market, employing new processes of manufacture from liquid hydrocarbons. Almost 95% of the carbon black produced goes into the making of tyres, for the manufacture of which sulphur and butadiene (also from petroleum) are also used. At the moment, two United States companies, Godfrey L. Cabot Inc. and the United Carbon Co., are operating plants in Great Britain, with capacities of 50 million and 110 million lb. p.a. Plants have recently gone on stream in France, Western Germany (where a changeover was made from naphthalene to the petroleum process) and Canada, while projects are scheduled for Brazil, Mexico and Australia. Thus it seems likely that the rubber industry outside the U.S. will cease to be dependent on American exports of carbon black, which in 1956 amounted to 425 million lb.

Short-time carbon production process

INDUSTRIAL carbon products that normally take eight weeks to make can be produced in less than eight minutes in a new multi-million-dollar plant that is now in operation at Lawrenceburg, Tennessee, U.S.A. The carbon products are formed in giant presses while powerful electric currents simultaneously heat the products to baking temperature.

With older carbon manufacturing processes, electrical baking of the mix is not feasible because the coating of the liquid binder on the particles of carbon flour makes the electrical resistance so high that extremely high voltages would have been required to force enough current through the mix to raise it to the necessary baking temperature. Special processing of raw materials has now resulted in a unique method of blending the mix that provides enough contact between the particles to lower the electrical resistance to the point that allows the initial flow of current. As the current heats the mixture, the binder is melted, and the pressure of the press forces it throughout the mixture, resulting in a thorough and complete mix, and providing outstanding uniformity in the finished carbon product, according to the Union Carbide Corporation, who developed the process.

Heart of the new system is a specially designed hydraulic press that operates at an average pressure of several tons per square inch. The extreme flexibility of the process makes it possible to change operating pressures, temperatures, and cycle timing in varying degrees to produce carbon products with a variety of properties.

Fresh water from brackish

THE evaporation and distillation of sea water is no longer the costly and somewhat haphazard business that it used to be, as an article in this issue shows. Considerable advances have been made, too, in the de-salting of brackish water by means of an electrodialysis process, one outstanding example occurring in the South African gold-mining industry where solar evaporation, involving extensive civil engineering works, is a costly business and considerable success has been claimed for the work on electrodialysis.

In the United Kingdom, an interesting de-salting process employing an electrodialytic membrane was recently demonstrated shortly before being installed in Tobruk for use by the Libyan Public Development and Stabilisation Agency. The process was developed by William Boby & Co. Ltd. in association with the Chemical Research Laboratory of the D.S.I.R., London, and the Central Technical Institute—T.N.O., The Hague, Holland.

The object of the plant is to produce at an economic price a potable water for domestic and agricultural purposes from brackish water with a high salt content. The brackish water flows through a cell formed from two ion-permeable membranes, one of which is permeable to positive, and the other to negative, ions. A small electric current is passed through the cell between two electrodes situated outside it. Rinse

water flows in the electrode compartments. The ions forming the salinity are attracted towards the electrodes according to their electrical charge. The effect is that the ions in the water passing through the cell move out of this water through the membranes into the rinse water flowing through the electrode compartments. The rinse water is discarded. The water leaving the cell is de-salted.

The process of de-salting is not complete without recirculating the water and, as a matter of fact, it will be stopped short in all ordinary use at a point where there is still some salinity left in the water, but the amount will be so small that it will be tasteless and potable in all respects. This is done for economy.

Electrical consumption is small and the process is claimed to be nearly 100% electrically efficient. It is possible to de-salt water so that it is fit for human consumption for about 7 kwh./1,000 gal. of water. This assumes that the water is of normal brackish quality, containing about 5,000 p.p.m. of salt. This is a good deal less than is found in sea water, but is nevertheless representative of a very large part of the world's natural water supply.

New 'hot lab' at Harwell

THE new building recently completed at the Atomic Energy Research Establishment, Harwell, for handling highly radioactive materials will make an important contribution to better design of nuclear power stations, for the building will be used primarily to dismantle highly active experimental reactor circuits to provide the test pieces and specimens for examination. A detailed knowledge of the behaviour of possible components for future power reactor systems under specific irradiation conditions is thereby obtained.

The building is designed to handle radioactive materials up to about 100,000 curies and contains five cells, separated from each other internally by removable shielding doors which are made from a steel shot concrete and weigh about 30 tons each. Materials within the cell are handled by a pair of master-slave manipulators. Individual cells are being equipped to carry out rough and fine machining, physical inspection and mechanical test work. The row of cells also contains a 1½-ton electric travelling crane, a travelling power manipulator and a self-propelled bogie of 5½ tons capacity.

The plant has been designed to do each part of the work as quickly as possible and the attention that has been paid to cell maintenance and to decontamination of the cells is obvious. Behind the cells there is a connected maintenance area which is fully equipped for operation by frog-suited maintenance workers. Active equipment is transported inside lead-shielded flasks and, for this reason, a 25-ton hoist is provided at the entrance to the plant. The spread of radioactive contamination from the cells and the cell-service area to the operating areas of the plant is prevented by a carefully balanced ventilation system. The input and extract sections of the ventilation system are separate.

Soviet advances in underground gasification

THE Soviet Union has come to be regarded as a dark horse in some fields of scientific and technological endeavour but it was hardly to be expected that the recent visit of a British team to the U.S.S.R. to study underground gasification methods there would reveal any spectacular advances in this field. It was known that the Russians have been operating several underground-gasification pilot plants for some time and that some enthusiastic claims have been made about certain aspects of the work done there, but, as Dr. W. Idris Jones pointed out in a recent paper to the Institute of Fuel, it has been shown that underground gasification contributes virtually nothing to the fuel resources of the country for the productivity of the present plants are poor compared with conventional mining procedures, the utilisation of coal reserves is low and scientific work on underground gasification has been unsatisfactory.

However, while the overall effect of Soviet underground gasification work on the country's economy may not be significant, the British visitors certainly gained a great deal of new and interesting information and a statement put out by the National Coal Board since the team's return gives a hint of some impressive advances in the U.S.S.R. which may or may not be applicable to British conditions. Certainly the protagonists of underground gasification in the U.S.S.R. seem to be supremely confident, as may well be justified by the fact that their economic surveys indicate that, in Russian conditions, the heat in coal can be supplied cheaper to the power station by means of underground gasification than by conventional or open-cast mining or by the new method of mining coal with high-pressure water jets and hydraulic conveying.

At Tula, in the Moscow brown-coal fields, the British party inspected an underground gasification plant which has been operating since 1940 and supplies gas for heating on a commercial basis to a number of manufacturing plants in Tula. The capacity is 42 million cu. ft./day of gas, of about one-sixth the calorific value of coal gas. The station also operates a sulphur recovery plant in connection with gas cleaning and manufactures sodium thiosulphate. The works pioneered the development of brown-coal gasification and is still used for the experimental work on which has been based the design of larger stations for power generation.

Among other places visited by the British team was Lisichansk, on the banks of the North Donets river, which has a gasification plant on hard coal in a traditional mining area where coal has been worked by conventional methods for over 200 years. Some 20 million cu. ft. of gas per day are produced here with the use of oxygen-enriched air. The use of oxygen for producing power gas is not essential and only continues because the large oxygen plant installed at Lisichansk has a regular sale for the inert gases, argon, krypton and xenon, produced as a by-product.

A feature of great interest in Russian work on underground gasification is the way in which the gas channel through the coal can be established by operat-

ing from boreholes drilled from the surface. This was done most ingeniously with a combination of air-drying of the wet coal and the working back of a fire zone towards the air blast. In another technique electrodes were passed down boreholes and used to make a connecting channel by applying a heavy electrical current. The equipment available for experimental and development work is on a considerable scale.

The British experts had a chance to see something of the scientific work on underground gasification that is being done in Moscow, and it is notable that at the Academy of Sciences, fundamental work is carried on into the kinetics of gas production in the various underground gasification zones, in close liaison with the scientific work on gasification processes in general. The laboratories are well staffed and equipped with mass spectrometers, radio-carbon apparatus, electrical analogue computors, ultrasonic equipment, and so on.

The application of oxygen and steam to the production of synthesis and town's gas is being closely studied both at the research institutes and in the field.

The visit has yielded material which will take some time to digest, and the return visit to Great Britain of a Russian party in March should strengthen the exchange of information which has now taken place.

Fertiliser from refuse in Thailand

A REPORT that the city of Bangkok, capital of Thailand, is to have the largest mechanised composting plant ever built means not only that Thailand will be ahead of many other countries in the economical and useful disposal of town's refuse but also that the country's importation of artificial fertiliser will be affected, especially if the Bangkok plant achieves a success that leads to the adoption of similar methods elsewhere in Thailand. Hitherto artificial fertilisers have been a major and increasing import of this country.

The Bangkok plant is designed to receive 1,100 cu.m. of refuse daily and magnetic and manual sorting will be followed by mechanical shredding and refining in ballistic separators which will remove fragments of non-ferrous metal, ceramics, etc., before sewage sludge is mixed with the garbage to form the raw compost. This will then be conveyed and distributed mechanically into special chambers in which the right conditions will be provided for the active development of aerobic fermentation in such a manner that temperature-duration conditions lethal to harmful organisms are created.

The composting process can be operated with or without sewage sludge, the garbage being mixed with water if sewage sludge is not added. Present plans at Bangkok are that certain quantities of dried sludge will be brought to the site and added as required. With a suitable sewage system available, the conveying of sludge could be completely mechanised with both sewage wastes and refuse being disposed of in a combined disposal unit.

While the purchaser of this plant, which will cost £714,000, is the Municipality of Bangkok, the Thailand Government has used considerable influence in the matter. The Department of Agriculture set up a pilot plant which has proved that the composting methods to be employed will produce compost of high value as a fertiliser. The contract for the large-scale plant has been won by a British company, John Thompson Industrial Constructions Ltd.

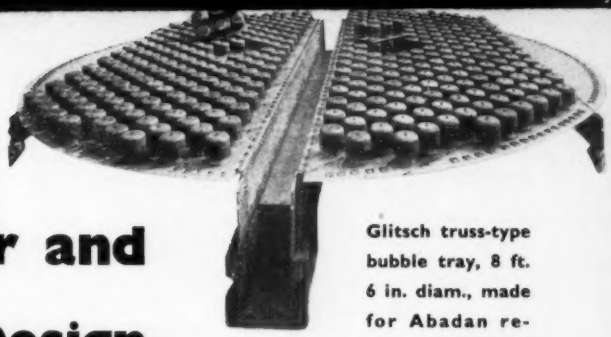
Chemicals and synthetic fibres

THE earlier regenerated fibres were made with the aid of ordinary chemicals, such as caustic soda, sulphuric and acetic acids, carbon disulphide, etc., which had already been made on a large scale over a period of many years, so that it was only necessary to expand their manufacture as the artificial fibre industry expanded. But in the case of synthetic fibres of the type of nylon, *Orlon*, *Terylene*, *Dynel* and *Acrilan*, production has required the chemical industry to provide new chemicals, as well as chemicals previously known and used only in the research laboratory. Moreover, most of these new chemicals are organic rather than inorganic, so that it has become necessary to call upon the petroleum and coal tar industries to supply the basic products for their manufacture.

These comments introduce an article on the subject of chemicals in the manufacture of synthetic fibres, by A. J. Hall, B.SC., F.R.I.C., F.T.I., F.S.D.C., in the January issue of our associate journal *Fibres*. Mr. Hall points out that the introduction of synthetic fibres is exerting a considerable influence on the chemical manufacturing industry, stimulating its activities by calling for increasing quantities of organic chemicals. In its turn the chemical industry is making new chemicals available of its own accord in the hope that they will sooner or later be taken into use by synthetic fibre manufacturers.

In considering the manufacture of synthetic fibres it will become evident that the chemicals required are of two types. In one group there are these chemicals which may be regarded as the fibre components, in so far as they are brought into chemical union in the formation of a fibre-forming polymer. In the other group are other chemicals, which are required to assist the conversion of the polymer into fibres but which do not ultimately form part of the fibre. In the main the two types of chemicals are fundamentally different. The first type must be highly reactive and able to form linear polymers of high molecular weight. The second type are generally required to be inert, and must certainly not be reactive towards the fibre-forming polymer. The latter type of chemical is required more particularly for use where fibre production requires the use of a dry or wet spinning process. It is not required in melt-spinning processes, such as are employed in the manufacture of nylon and *Terylene*.

In concluding his article, which gives an account of the character and manufacture of the various chemicals used in the production of synthetic fibres, Mr. Hall emphasises that the present synthetic fibres have their defects, and that there is always a strong incentive to discover alternative chemicals which might be used to give improved fibres.



Glitsch truss-type bubble tray, 8 ft. 6 in. diam., made for Abadan refinery by Metal Propellers Ltd.

Progress in Absorber and Fractionator Tray Design

Recent developments in the design of trays for fractionation and absorber towers offer effective competition to bubble-cap plates, long-term standard in refinery service. Considerable work has gone towards defining more clearly the boundaries of usefulness of bubble-cap trays. At the same time, new designs have quickly reached significant commercial stature. In many applications, the new types of tray offer greater simplicity, better operating flexibility, ease of maintenance, and lower initial cost than can be realised with bubble-cap trays.

OUTSTANDING examples of the new tray designs include the *Turbogrid* (Shell Development Co.), *Uniflux* fractionating tray (Socony-Mobiloil Co.), the Benturi *Kaskade* and *Flexitray* plates (Koch Engineering Co.), float valve bubble trays (Nutter Engineering Co.) and perforated plates. The last-named design is not new, having been used for a number of years in beer stills and where sedimentation has been a problem. Only during the last five years or so has wide applicability of perforated plates to operations in the refinery and chemical industries been realised and put into effect.

All these trays have the objective of providing intimate contact between vapour and liquid phases with minimum pressure drop, maximum efficiency, and small entrainment. Katzen[1] points out that, in the last analysis, all tray designs go back to the same basic concept. Thus the *Uniflux* tray is reached by arranging the bubble cap's slots in a straight line. Flattening the slots and turning them into rectangular shape produces the *Turbogrid* tray, which becomes a perforated plate by changing the slots into circles.

Effect of entrainment ratio

But in actual practice and performance, there is a significant difference between the various tray designs. It is furthermore interesting to note that the minimum tower cost, regardless of tray spacing or type of tray, is reached at the same entrainment ratio, namely 0.175.[1, 2] Here the entrainment ratio is expressed as lb. liquid/lb. vapour, and the maximum permissible entrainment for minimum tower cost is expressed by the relation:

$$e_m = 0.175\ L/V$$

where L = liquid downflow rate (lb./hr.) and V = vapour upflow rate (lb./hr.). In its turn, the chosen entrainment ratio influences the actual number of trays which must be installed for a given service and the tray efficiency. This subject has been discussed by Colburn.[3]

The practical effect of this constancy of optimum entrainment ratio gives advantage to a tray which will cause small entrainment at a given liquid: vapour operating ratio and this is an important objective of tray design.

Bubble caps and their limitations

The basic principle of bubble-cap design and operation is generally known. There are today literally hundreds of designs and sizes on the market. Frequently, deviation from the simplest design has been explained on the grounds of providing more intimate contact between the phases, but this is often accomplished at the cost of increased pressure drop per plate, and hence greater proneness to entrainment.

Young[4] points out three reasons which are largely responsible for the long-term popularity of bubble caps: flexibility as to feedstock, good performance over a wide range of operating conditions (liquid and vapour rates) and relatively low maintenance cost.

On a graph of vapour load *versus* liquid load, the range of satisfactory operating conditions is a clearly defined area, limited by four conditions: (1) coning; (2) (*a*) blowing and (*b*) entrainment; (3) flooding; (4) (*a*) pulsation and (*b*) dumping. The exact levels at which any of these conditions occurs depends on the physical characteristics of the process system and on the details of tray design.

(1) *Coning* may occur at excessively low liquid rate. This is a condition where the liquid seal above the slot is insufficient, so that vapours are passed without contacting the liquid. Young points out that the minimum practicable liquid seal, to avoid coning, is 0.5 in. Liquid height on the plate is the sum of weir height plus liquid crest above the weir. At low liquid rates, this latter component may disappear to negligible value, thus exposing the upper end of the bubble-cap slots.

(2) *Blowing and entrainment* occur at excessive vapour

rates. At such vapour loads and low liquid loads, blowing is observed, which means that the liquid is simply blown away from a position on the tray where intimate contact can occur. As the liquid rate is boosted, entrainment may set in, a condition in which liquid particles are carried from one tray to the tray above it.

(3) *Flooding* is a condition at very high liquid loading. Here the downcomer pipe is filled with a mixture of foam and liquid which eventually overflows to the next upper tray.

(4) *Pulsation and dumping* are tower phenomena at low vapour rates. Low vapour rate combined with low liquid load leads to pulsation, *i.e.* intermittent passage of vapour. Such a condition causes poor plate efficiency. At low vapour rates and high liquid load, liquid may pass through the riser of the bubble caps, thus short-circuiting the contact tray.

Young[4] has reported qualitatively the significant effect of bubble-cap plate design details on the point where each of the above phenomena will occur. Application of such knowledge permits, of course, widening of the effective area for satisfactory tower operation. Thus pulsation is affected by cap size and slot area; dumping can be staved off by providing an inlet-dam upstream of the first row of caps. To avoid coning, a liquid seal of at least 0.5 in. must be maintained above the slots. Blowing is influenced by the area of the bubble-cap slots, the skirt clearance between the cap teeth and the tray, and by the size of the caps. Entrainment is influenced by tray spacing, bubble-cap type and size, and by tray layout. The flooding point is affected significantly by hydraulic gradient and by design of downpipe. Each of the critical conditions is, of course, also influenced by the properties of the process system, but this consideration is beyond the scope of the present discussion.

Such knowledge of critical design factors—as well as improved mathematical tools for column design—has a very striking effect on tower economics. Young has estimated the dimensions of a typical bubble-cap fractionator in cyclohexane service, (*a*) according to the best information available in 1948 and (*b*) according to the best information available in 1954. He found that the 1948 design would have called for a 144-in.-diam. tower with 125 actual trays. The 1954 design specified a tower of 114-in. diam. and with 96 actual trays. The capital savings due to the six-year advance in engineering are $60,000, about one-third of column cost.

Better realisation of bubble-cap potentialities and improved design methods are thus actively involved in the continuing popularity of this design, in the face of competition from new types of tray. The development is thus toward establishment of areas in which each design is the optimum, and evaluation is required for the individual case.

Because of their long-established position as refinery standard for tray-type fractionators and absorber columns, the following discussion will use bubble-cap plates as basis for comparison for trays of new design.

' Turbogrid ' tray

The Shell Development Co.,[5] licensor of the *Turbogrid* design, reports that the unit is characterised by high capacity, low pressure drop, low liquid hold-up and substantially standard efficiency per foot of tower height. The simple construction of *Turbogrid* trays is responsible for low initial and maintenance costs. Essentially the plate consists of parallel slots which extend over the entire cross-section of the column. Mechanically, this design is achieved by stamping from a plate or by laying parallel bars of regular spacing. A structural framework is provided on the plate's underside as may be called for by tower diameter and metal thickness.

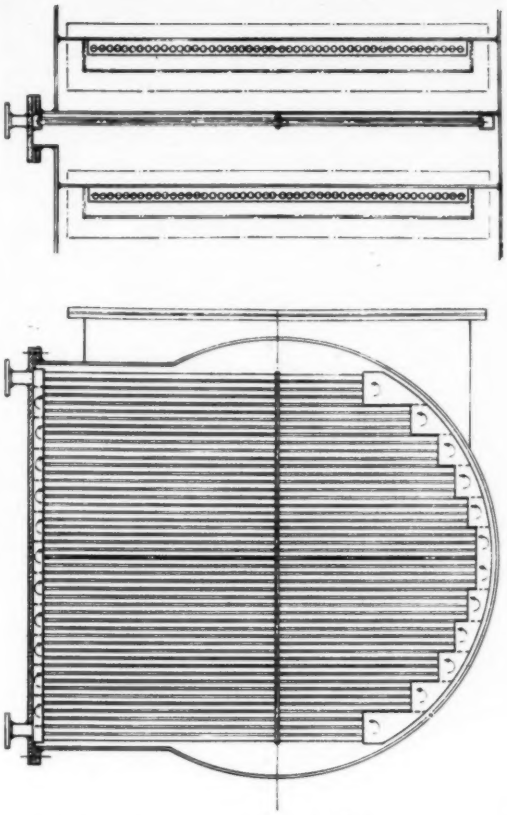
An important feature of the *Turbogrid* tray is the absence of downcomer pipes. Instead, the parallel slots in the plate serve as vapour risers as well as for liquid downflow, and liquid level on the plate is set by dynamic balance between the two phases. This absence of downcomers has the advantage of leaving a greater effective contact area per square foot of plate than is possible in bubble-cap plates where risers, downcomers and caps take up some 15 to 17% of the total cross-section. On the other hand, the need for maintaining hydraulic balance between vapour and liquid imposes a closer limit on the feasible operating conditions, thus detracting from the column's flexibility. However, the practicable operating range can be widened toward low flow rates by blanking off some of the slots. Alternately, high rates can be achieved by providing downcomers in the plate after all. In that event, the plate behaviour approaches that of a perforated tray (see below). Use of downcomers has also been mentioned for the operation of very large-diameter plates and with very high liquid rates. But, as stated earlier, downcomers are in general not recommended for reasonably normal service.

Pressure drop through bubble-cap trays may be fairly high, since it is necessary to overcome not only the liquid level on the plate but also the flow resistance of the restricted and contorted path through the bell cap. On *Turbogrid* trays, the vapour travels in a straight line so that the pressure drop is substantially equal to the liquid level on the tray only.

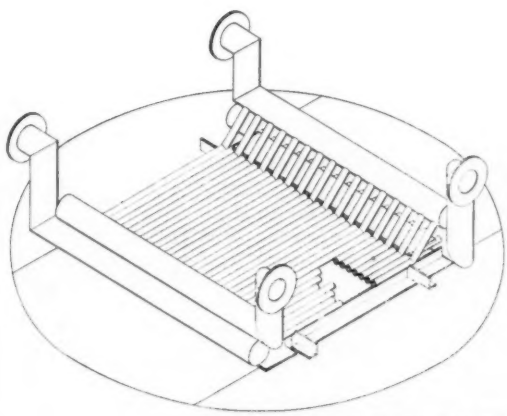
Considerations which have a determining influence on a selection of slot width include capacity, possible pressure-drop limitations, and likelihood of corrosion or fouling. According to Shell Development Co., a large open area provides the greatest capacity, but at the cost of maximum efficiency and operating flexibility. Tray spacing is normally between 12 and 18 in., with the latter distance more common in towers of large diameter.

Shell Development Co.[5] has reported results in the operation of *Turbogrid* plates in gasoline fractionation service. A tower was used which had previously been designed and operated in the same service, but with bubble-cap trays. *Turbogrid* trays gave better than original design performance at design rate. Indeed, specification separation was attained over a range from an

' Turbogrid ' slotted distillation tray, 4 ft. in diam., in 12/14% chrome material.



A logical development from the 'Turbogrid' tray is the 'Thermagrid,' in which tubes take the place of the normal bars or slotted plates. In 'Thermagrids' heat can be added or removed, as required, at tray level and in the tray. The above diagrams show a 'chest of drawers' construction for a 'Thermagrid' tray with single header. Each tray can be quickly removed for inspection purposes. For small and medium-sized towers.



[Illustrations on this page, and on pages 41 and 42, are by courtesy Metal Propellers Ltd.

Another arrangement for a 'Thermagrid' tray, suitable for large towers, with double headers and minimum connections through the column walls.

estimated 60 to 120% of design throughput. Comparative data for bubble-cap plates are not available in this instance.

Results are reported for a so-called de-ethaniser column which had, however, the primary function of producing an overhead containing minimum practicable C_3s. The fractionating tower under study has a diameter of 4 ft. in the rectifying section and 5 ft. in the stripping section. The original installation contained 13 bubble trays in the rectifying section and nine stripping bubble-cap plates. These were replaced by 19 and 11 *Turbogrids*, respectively, spaced at 12 in. Operating pressure was 500 p.s.i.g. Feed was introduced at 4,800 bbl./day and reflux was provided at 2,000 bbl./day. The following percentage recoveries were obtained:

	Bubble cap	*Turbogrid*
Overhead:		
C_2	59	66
C_2	49	45
Bottoms:		
C_3	95	95
C_3	97	98

On the count of first cost, *Turbogrid* trays appear to have an advantage over other tray designs which are today available. For example, Katzen[1] reports that bar stock *Turbogrid* trays of 6 ft. diam. cost only slightly more than $110 per tray (1953 prices). This compares with $400 for a typical bubble-cap tray of like size. However, royalty payments chargeable for *Turbogrid* trays reduce the overall savings by about 20% for new towers—more in the case of replacement jobs. The cost advantage may be expected to be even more pronounced in the case of alloy steels, plastics, or ceramic towers.

Socony's 'Uniflux' tray

This is another recent design which has acquired quick popularity. More than 200 commercial towers using the *Uniflux* tray are reported to be in operation or under construction.

The *Uniflux* tray employs the same principles of vapour and liquid flow as do bubble-cap plates. However, the contact element, instead of being circular, is a rectangular channel running across the entire tower width. These channels are set in parallels so as to compose a tray. The tray is not completely circular since an end segment is omitted to serve as inlet to the downcomer pipe. The vertical downcomer flange (weir) is attached to the last vapour section of the tray and runs parallel with it.

The essential feature of the *Uniflux* tray is that it is made up of modular S-shaped units which are assembled so that the vertical and wall of one such unit (or vapour section) interlocks with that of the next one. Triangular segments are cut out of one vertical side of each S-shaped vapour section and serve as points of vapour entry into the liquid on the tray. These slot areas constitute 12 to 14% of the superficial tower cross-section.

Between them, these vapour sections constitute the tray proper—as well as the 'bubble caps,' *i.e.* the units serve structurally as well as functionally. An important consequence is that each member needs to support only a relatively small amount of liquid—and of steel—so that relatively thin-gauge metal may be used. Bowles[6] reports that 16-gauge steel may be used without further structural support in towers of up to 10 ft. diam. For towers up to twice that size, the same metal thickness is adequate with a single intermediate support beam. Obviously, this constitutes good metal savings over standard columns.

Furthermore, the modular nature of *Uniflux* trays cuts to a minimum the variety of replacement parts which need be warehoused.

Functionally, an important point in favour of *Uniflux* trays is the unidirectional flow of vapour. This makes it possible to overcome efficiency losses due to hydraulic gradient which is a problem in bubble-cap towers of very large diameter. Furthermore, the riser area of *Uniflux* vapour sections, as well as the vapour reversal area, are several times larger than the corresponding components of bubble caps, with the result that low pressure drop is attained.

Katzen[1] reports the cost of *Uniflux* trays of 16-gauge 12 chrome alloy at $6 to $7 per sq. ft. of area. This includes royalties. According to Bowles,[6] the cost per tray is about 60% of that for a conventional bubble-cap tray of the same material. About the same cross-sectional area is required for either design at a given design loading.

Relative efficiency of *Uniflux* and bubble-cap trays is reported to be about the same at design conditions. However, insufficient data have been published so far to determine whether equal efficiency applies over the entire range of conditions which are likely to be encountered. In particular, the question has been raised whether the large slot openings of *Uniflux* trays may lead to low efficiency at small vapour leadings. If this should prove to be a problem, it may be quite possible to overcome it by modification in the slot design for special situations.

Float valve bubble trays

In the foregoing discussion we have mentioned repeatedly that efficiency and even operability of a particular tray design is influenced by flow rates as per cent. of design conditions. Ideally, the free area for vapour passage should decrease as vapour rate is reduced.

An approach to this situation is offered by trays in which the tray openings vary with the rate of vapour flow. Definite advantages in flexibility and in high plate efficiency over a wide range of operating conditions may be derived therefrom. Since trays of this type, which have been envisioned so far, incorporate movable elements, difficulties may occur in service which can lead to obstruction of the mechanical element, *e.g.* due to coking, corrosion, sedimentation, etc.

Nutter Engineering Co. (Amarillo, Texas) offers a ' float valve bubble tray ' in which the effective riser area is controlled by a superimposed value acting on a pivotal principle. The first commercial installation was a 6-ft. absorption tower in natural gasoline service, which was taken on stream in September 1951. Performance data on this type of tray have since been reported by Nutter.[7]

At zero gas flow, the float valve tray allows some weeping through mechanical imperfections. However, even at very low vapour ratio, this weeping action disappears. Construction of the valve is such that the lateral pressure of liquid on the valve (due to hydraulic gradient across the tray) is always less than the downward pressure which tends to shut the valve. Thus opening of the valve, regardless of liquid rate, can be accomplished only by the pressure of the vapour.

The lowest liquid level on the tray exists, of course, at the weir line of the exit downcomer pipe. It is here, therefore, that the least resistance is offered to vapour flow. At low gas rates, the bulk of vapour enters the body of liquid close to the exit downcomer. But as vapour flow is increased, other valve lines open successively in progression from the exit downcomer weir towards the entrance downcomer where the liquid level is greatest.

Initially, the valve opens in pivoting action, since its two sides (seen in elevation) are of non-uniform weight. At vapour rates near 40% of design, the valve's heavy side begins to rise as well until the entire shut-off plate is removed from the point of vapour entry and floats horizontally, held in position by a fixed horizontal bracket. At about 70% of design, all valves are in open position and they remain this way at higher rates. Thus the valve action extends stability of the tray action below the limit of conventional trays (50 to 70% of design) down to almost zero flow rate.

An important feature of the unit is that the valve-controlled horizontal openings are themselves the distributing slots. Flow of vapour is therefore subject to fewer turns than is true of bubble caps, and pressure drop is, accordingly, low. The tray liquid is covered by a continuous froth which is said to favour low entrainment. The float valve units are of small height, thus offering minimum obstruction to liquid flow across the tray. Nutter states that there is practically no liquid gradient across the tray above 20% loading.

While there is risk of fouling, Nutter states that this objection is reduced to a minimum due to active operation at all capacities. The self-adjusting nature of the design makes it possible to restore operation after interruptions with a minimum of adjustment.

Benturi ' Kaskade ' tray

The Benturi plate (Koch Engineering Co.) consists of a number of parallel blades which are bent so as to deflect the vapour rising between them from a vertical to a horizontal direction. Liquid flows across the plate in the same direction as the entering vapour which serves to provide effective mixing and contact between the two phases.

The vapour passages are in the shape of a bent venturi. This design permits maximum recovery of the energy content of the entering vapours and thereby holds pressure drop per tray at a minimum. Perforated baffles above the plate even out the liquid level across the plate.

The Benturi tray was given its first commercial test in 1950. During the intervening years, it has been proven to be of special value in installations calling for high vapour velocities (especially in absorber and stripper units) and operating results have only now been made available.

An essential factor in this design is the elimination of the large liquid gradient which characterises bubble-cap trays. In the case of conventional distillation plates, a high liquid level surrounds the bubble caps in the region where the liquid downcomer pipe feeds the plate. At the opposite end of the plate, the liquid level is very much reduced. As a result, vapours travel preferentially through the liquid outlet end of the plate. At this point, then, there will be a strong tendency to liquid entrainment, which liquid may actually flow down through the bubble-cap risers at the opposite end of the plate. Such a condition results, of course, in considerable reduction in plate efficiency and in permissible overall vapour velocity before flooding of the column is obtained.

The Benturi tray overcomes much of this difficulty by providing a uniform system of liquid-vapour contact over the entire plate area. Contact time between the phases is therefore approximately the same at all points, and vapour velocity is quite uniform. It therefore becomes possible to operate at overall vapour rates which exceed permissible velocities in bubble-cap columns by as much as 100%.

Benturi trays permit therefore the use of considerably

smaller tower diameters than would be feasible if the same load were required in bubble-cap design. At the same time, the avoidance of localised high-velocity vapour flow and the elimination of the tortuous vapour path of bubble caps results in a considerable reduction in pressure drop through the system. It is also claimed that maintenance requirements are reduced and that very much higher tray efficiencies can be obtained.

The Benturi tray is an improvement over the earlier *Kaskade* tray which has already found wide acceptance in the petroleum industry. The advantage of the Benturi is that it allows even higher vapour rates and lower pressure drops because its vapour flow is directed through a 90° turn only, compared to a 180° turn taken in the *Kaskade* system.

Thornton reports the case of an absorber tower operated at a liquid flow rate of 113.2 gal./min. Under these conditions, the original bubble-cap trays permitted a vapour throughput of 15,000 M.c.f.d. before entrainment difficulties limited efficient tower operation. Upon substitution of *Kaskade* trays in this tower, the vapour rate could be boosted to 19,642 M.c.f.d. without the occurrence of entrainment. In this case, the limiting capacity was estimated at 21,500 M.c.f.d.

The Benturi design of the new tray makes it impossible for liquid to flow downward through the vapour riser slots unless an excessive liquid level is accidentally obtained. Overflow weirs for the liquid are provided at the end of the tray. The position of the downcomer is, of course, alternated for successive trays in order to necessitate flow of the entire liquid phase across each of the plates.

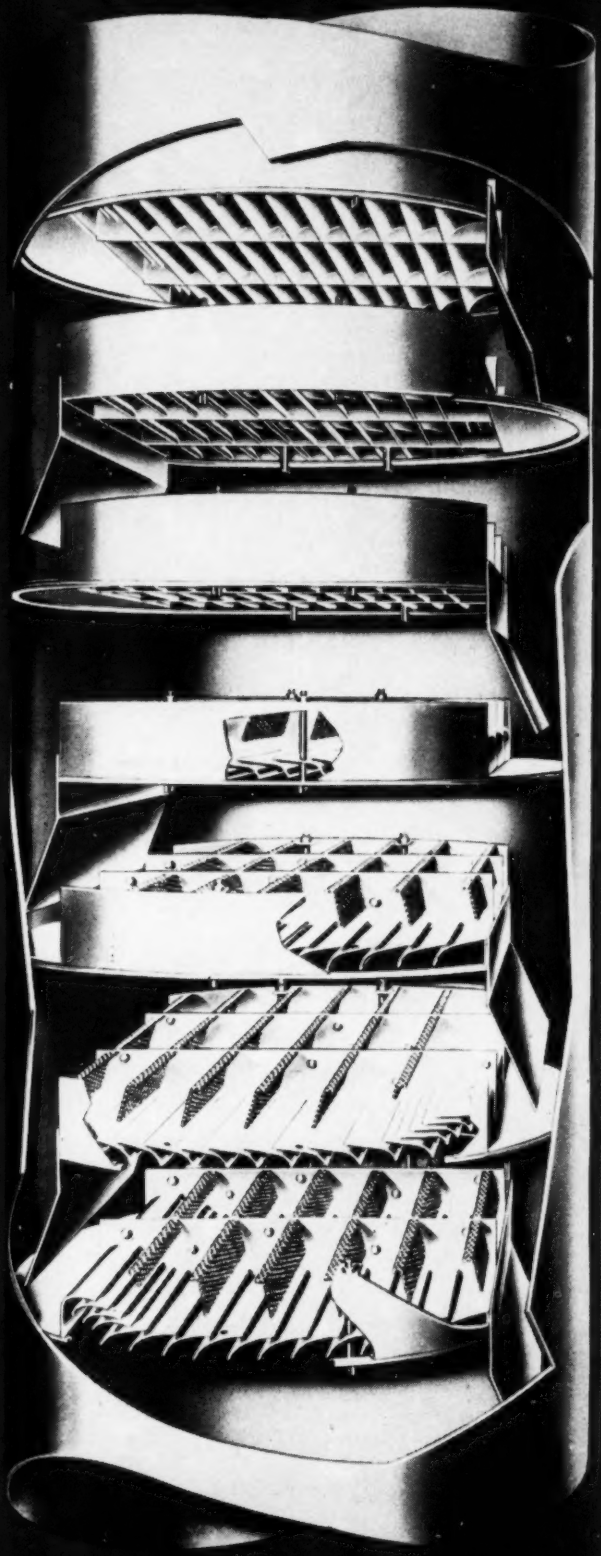
Liquid hold-up on each Benturi tray is only about 30 to 40% of that normally obtained on bubble-cap trays. This is of significance where the distillation of thermally sensitive materials requires low hold-up time in the column in order to keep yield-consuming polymerisation and degradation reactions at a minimum.

This type of tray finds its ideal field of application in operations in which a very high ratio of vapour to liquid is required. Among the principal fields of interest in the petroleum industry might be mentioned: crude distillation, amine desulphurisation, various stripping operations, absorption, and L.P.G. recovery in natural gasoline recovery plants.

However, the design is flexible. If advantage is to be taken of the high-capacity characteristics of the unit at somewhat higher liquid ratios, this can be achieved by decreasing the riser slot area and increasing the relative size of the downcomer weirs. The important effect of this measure will be to make it impossible for even the higher liquid level on the plate to force a downward flow through the intended vapour passages, and thus to lower the efficiency of the column by partial short-circuiting of the tray. It should be noted, however, that such remedial measure will result in a somewhat higher pressure drop per unit plate. Nevertheless, even under such circumstances, the overall pressure drop still compares favourably with the observations in a bubble-cap tray column.

Tray spacing for Benturi column is recommended to be between 18 and 36 in., as is the case with standard bubble-cap plates.

It is noteworthy that the Benturi tray, like its prototype, the *Kaskade* plate, shows efficient performance in liquid-liquid extraction, just as it does in absorption and distillation service. In the case of liquid-liquid extraction, the process system will determine whether the optimum position of the plate will have the entrance slots pointing upwards or downwards (as is the case in liquid gas diffusional operations).



The 'Flexitray'

The *Flexitray* (Koch Engineering Co.) is an approach to plate construction with variable vapour slot openings. The philosophy behind such design has been discussed above in connection with the 'float valve' bubble tray. However, details of the design differ in the *Flexitray*.

The unit is essentially a sieve plate on which the horizontally placed vapour openings are covered by liftable valves of approximately 2-in. diam. At zero vapour rate, these valves are closed, and thus prevent weeping. As vapour flows to the tray bottom, the pressure differential forces the liftable valves into open position where they are held in place by a superimposed spider.

The weight of valves in alternate rows differs. Thrift[8] states that the lighter valves open at 20 to 30% of vapour design rate, while the heavier valves open at 50 to 70% of design capacity. In this way, a wide range of operating conditions can be covered with stable tray performance.

Since the valves are very low (approximately $\frac{3}{4}$ in.) a near-negligible hydraulic gradient exists on the tray. Vapour entry takes place with minimum flow resistance. Distribution into the liquid is in horizontal fashion. This offers the reported advantage of minimising the coning tendency of a system.

According to Thrift, pressure drop through *Flexitrays* of 18-in. spacing is 2.5 to 3.5 in water in the test system air-water. Such small pressure differentials make possible the use of small downcomer sections. For viscous absorber systems, tray efficiency of *Flexitray* units is reported to be as high as 70 to 90% in absorber service *versus* only 25 to 30% for typical bubble-cap trays. Prices are in line with bubble-cap construction.

Perforated plates

Use of perforated trays for distillation and absorption purposes is not new, but their widespread application in refinery and chemical operations is a development of the last five years. Previous objection to the adoption of this simple design has been based primarily on the belief that weeping would occur at vapour loadings only slightly below design, thus restricting the tray's stable operation to a very narrow range. Recent investigations have shown that this is not the case. With proper design, a sieve plate may be used efficiently over a wide range of operating conditions.

Perforated, or sieve, plates are exactly what the name implies—plates with regularly spaced holes which act as vapour slots. Downcomer pipes for liquid flow are provided—usually at one end of the tray—in the conventional manner.

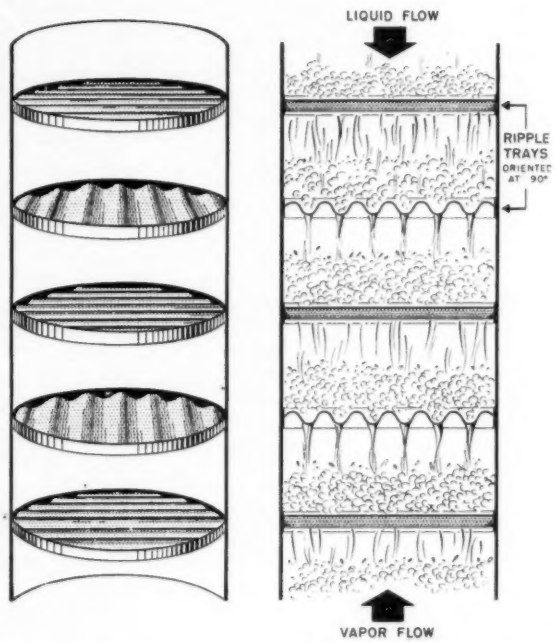
The holes in the tray may be either drilled or punched. The latter method is considerably less expensive, but—in the case of most common metals—the punching process limits the plate to a thickness which is not in excess of the hole diameter (in the case of stainless steels, the plate thickness cannot exceed two-thirds of hole diameter). For most commercial purposes, a hole diameter of $\frac{3}{16}$ in. is indicated, so that punched plates satisfy most demands of refinery service.

Considerable experimental work and commercial experience on perforated plate use has been accumulated by Celanese Corporation of America, and conclusions are reported in two excellent publications.[9, 10]

The method for calculating pressure drop through the holes and liquid layer is outlined by Mayfield.[9] The desired pressure drop determines the permissible number of holes. If a large range of operating conditions is to be accommodated, a fairly high pressure drop may have to be taken at maximum vapour rates. For typical design, and with 18-in. tray spacing, a 4- to 5-in. pressure drop is representative near the upper limit of vapour rates.

The range of operating conditions may be extended toward lower vapour rates by blanking off some of the holes. This is done by tack-welding metal strips to the tray's underside. This method of adjusting to flow rates is recommended particularly if large differences in vapour rates are encountered within a single column, since blanking permits use of a standard tray and thus minimises the warehousing problem.

Mayfield recommends recessed seal weirs. This permits the use of perforations close to the inlet weir without the occurrence of weeping at this point. Lee[10] points out that the same considerations control in perforated and in



[Courtesy: E. B. Badger & Sons Ltd.

These two diagrams show the Stone & Webster ripple tray. *Left:* **Orientation of trays in tower.** *Right:* **Schematic view of working trays.**

bubble-cap trays for the selection of tray spacing, number of trays, and downcomer dimensions. On mechanical grounds, however, it must be noted that sieve plates are more susceptible to plugging from sediment and coking in service where such possibilities exist. Against this, the perforated plate offers the advantage of readier and easier maintenance.

Today, perforated trays find widespread application in both absorption and distillation service. An interesting comparison of bubble-cap and sieve trays in commercial absorption towers is due to Kelley.[11] The work was carried out with absorbers used for the recovery of propanes and heavier hydrocarbons. Operation was at 65 p.s.i.g. and 32°C. Originally, the 6-ft.-diam. tower contained 25 bubble-cap trays. Owing to corrosion, these had to be replaced and, in their stead, 25 perforated plates were used. This substitution led to very substantial increase in tower capacity. Limiting gas and oil rates are reported as in Table 1.

Kelley reports further that the perforated trays permitted a wide range in operating rates without difficulty.

Efficiency was substantially the same as in bubble-cap trays. Kelley concludes that the small local efficiency, which is characteristic of absorber service, masks advantages in overall tray design. A more conclusive comparison of tray efficiencies must look to fractionator data.

Several studies are at hand which confirm that, in distillation service, overall efficiency of sieve trays is superior to the performance of bubble-cap plates. Mayfield's investigation[9] involved the fractionation of mixtures of the lower aliphatic alcohols. Comparative tray efficiencies are provided in Table 2.

It is clear that sieve trays show consistently a significantly better efficiency factor. This is in accord with theoretical predictions developed by Gerster.[12]

Pressure drop through perforated trays is significantly less than is observed, at equal per cent. of design rate, in bubble-cap towers.

Cost-wise, perforated plates are intermediate between *Turbogrid* and bubble-cap plates. Katzen[1] states that perforated tray towers will cost between 60 and 70% of bubble-cap tray towers for the same design conditions.

Ripple trays

A recent, commercially important contribution to the field of distillation and absorption apparatus is the ripple tray developed by Stone & Webster Engineering Corp. Trays of this type are, in effect, perforated plates which have been bent into sinusoidal waves. No downcomer pipe is provided. Instead, the contour of the wave acts as guide to the liquid downflow. Other advantages are claimed for this design as well. Thus the waves provide rigidity and permit the use of light-gauge sheet metal. Furthermore, the shape of the plate introduces a new, third-dimensional design variable which may be optimised for the system to be handled.

Hutchinson and Baddour[13] have investigated operating performance of ripple trays in distillation service. They find that efficient operation can be obtained over a wide range of vapour flow rates. However, the height of liquid froth on each plate varies more pronouncedly with throughput than is the case on standard (flat) perforated plates with downcomer pipes. With froth height, pressure drop is also strongly affected by flow rate.

The liquid on each ripple plate is in a state of greater turbulence than is the case on flat perforated trays. The result is not only good plate efficiency but also lesser tendency to plate obstruction by deposition of solid particles which may be present in the liquid phase (*e.g.* the formation of 'popcorn' polymers in styrene purification appears to be absent in ripple trays).

Ripple trays are reported to show lower pressure drop than bubble-cap column trays. To obtain the same pressure drop at a given flow rate, ripple plates are stated to call for approximately one-half the tray area required by typical bubble-plate design.

The case for ripple trays is illustrated by a commercial oil refinery crude distillation unit in which the original bubble-cap plates were replaced by ripple trays. The new plates were installed in the same shells in all locations affected by loading. This change boosted permissible throughput from 20,000 to 31,500 bbl./day. Even at the latter value, tower capacity was not yet limiting. Fractionation in the revised unit at its higher throughput was generally comparable to performance of the initial installation.

Table 1. Comparison of Bubble-cap and Sieve Trays in Absorption Towers

	Feed gas, M.c.f.d./sq.ft.	*Rich oil, bbl./day/sq.ft.*
Bubble-cap trays	348	448
Perforated plate — with blanking strips	543	923
Perforated plate—without blanking strips	649	923

Table 2. Comparative Tray Efficiences of Sieve and Bubble-cap Trays

Run No.	*6-ft., 60-tray sieve plate column*		*2-ft., 35-tray bubble-plate column*	
	*Steam rate, lb. (hr., sq.ft. tower area)**	*Tray efficiency,† %*	*Steam rate, lb. (hr., sq.ft. tower area)**	*Tray efficiency,‡ %*
1	262	58.7	247	50.3
2	321	67.3	485	51.0
3	270	63.2	493	45.7
4	233	63.5	175	46.0
5	180	64.5	111	34.7
6	118	63.5	630	47.9
7	—	—	653	34.3

* Alcohol vapour rate is approximately 3.5 times steam rate.
† Tray 30 to tray 52 (approximately same concentrations as on trays 4 to 32 of 2-ft. column).
‡ Tray 4 to tray 32.

The new plates were installed in the same shells in all locations affected by loading. This change boosted permissible throughput from 20,000 to 31,500 bbl./day. Even at the latter value, tower capacity was not yet limiting. Fractionation in the revised unit at its higher throughput was generally comparable to performance of the initial installation.

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Phosphorus and Fluorine

This monograph* is concerned with the chemistry and toxic action of organic compounds which contain phosphorus and fluorine. Besides their toxic effects, which make these compounds an obvious choice in chemical warfare, many of them are useful to biologists in the investigation of enzyme systems, to agriculturists as constituents of insecticides, and to doctors in the treatment of glaucoma and other illnesses.

Dr. Saunders writes mainly with the advanced student of chemistry and the industrial chemist in mind, but the book is unusual in combining a number of different aspects of the subject, and can also be read with profit by those engaged in medical and biological research.

Dr. Saunders was the discoverer of one of the compounds discussed in this book, DFP, a typical 'nerve gas,' and of a number of related substances. The monograph arose as a result of a series of lectures given by him at Delft and Leiden in 1950.

* 'Phosphorus and Fluorine,' by Dr. B. C. Saunders, Cambridge University Press, 1957. Pp. 231, 32s. 6d.

[*Courtesy: Silvertown Rubber Co. Ltd.*
Trough lined with ebonite for a well-known manufacturing chemist.

Rubber in Chemical Engineering

(Specially Contributed)

This article gives a picture of rubber as a protective material which combines a high degree of corrosion resistance with extreme adaptability. Where resistance to both corrosion and abrasion is required the necessary properties can usually be combined in the same rubber compound. Rubber is seen to be capable of affording protection not only to vessels, pipes, pumps, valves, etc., but also to the structure of buildings and plant, to tools and equipment and to operatives themselves.

THERE have been great improvements in the compounding of rubber and the chemical engineer no longer has to make a clear-cut decision between, on the one hand, a very soft rubber subject to ageing and on the other hand a hard rubber, or ebonite, which may be too brittle for certain conditions. With the introduction of anti-oxidants, softeners and fillers of fine particle size, it is now possible to compound natural rubber to any degree of hardness and make it completely resistant to chemical attack over a wide range of corrosive solutions.

The engineer's choice is influenced by the degree of flexibility or rigidity required, the concentration and nature of the corrosives present, their temperature and the kind of apparatus through which they have to pass. If, for instance, he has to provide a flexible hosepipe or a conveyor belt for carrying chemicals, fairly soft rubber is the obvious choice, but if the requirement is a rigid article such as a stopcock or valve, destined to spend most of its life submerged in corrosive materials, a very hard rubber will be specified. In between, there are applications where the choice is not so obvious.

It not infrequently happens that soft and hard rubbers are used in different places on the same plant, often in close juxtaposition. One example, which occurs in America, is a tank lorry lined with two layers of soft rubber sandwiching a layer of ebonite, thus providing a lining of very great corrosion resistance combined with shock-absorbent properties. This tanker was 'tailor-made' to provide over-the-road transport for a chemical solution used in bleaching.

Soft rubber

Soft rubber is used to line storage vessels from the small transport tanks carried on lorries and trains to vast reservoirs containing many thousands of gallons of corrosives. An example of work of this kind on a really imposing scale was the lining of the bromine plant set up a few years ago on the Isle of Anglesey (see CHEMICAL & PROCESS ENGINEERING, 1954, **35** (4), 115-120). During processing the sea water is acidulated in a vast steel and concrete tank protected by rubber and ebonite. The cells of the concrete blowing-out tower, for example, were lined with unvulcanised rubber sheet, afterwards vulcanised *in situ* by hot air. The work involved the application of 170 tons of rubber lining, the total area of lining being approximately 250,000 sq. ft.

While in the case of very large equipment, such as the foregoing, the work may be carried out on the site, smaller items of equipment can be sent to one of the many companies who specialise in rubber-lining work. In the usual method of lining the sheeting is applied in thicknesses ranging from 2 to 4 mm. and the vessel is first cleaned, probably by sand blasting. The rubber sheets and the walls of the vessel are next coated with adhesives and the sheeting applied to the walls rather in the same manner as wallpaper; any entrapped air is expelled as the work proceeds.

In vessels and pipes where abrasive slurries are handled and in ball mills, chutes and similar equipment, suitably compounded soft rubber shows its qualities of resistance to abrasion. A good illustration of this is afforded by the lining of a new type of hydrocyclone used for separating heavy from light dispersions by means of centrifugal force. This is done by introducing water at high pressure into the vessel which is cylindro-conical in shape. The separation of the particles is carried out by means of a vortex of water in which a high centrifugal force of the order of 15,000 *G* is developed. Abrasion increases as the apex orifice is approached and, for this reason, the hydrocyclone is fitted with an easily removable apex nozzle of solid rubber, the walls of

which increase in thickness towards the orifice, providing maximum protection where it is most required.

A means of grading aggregates employed by modern concrete designers uses rubber nozzles as an important feature of the design. Rubber has been found from experience to be the only material strong enough to stand up to the abrasive wear met with in this process of elutriation.

Pipe linings

Another most important use of soft rubber is for the external and internal linings of pipes for carrying corrosive liquids and gases. These linings not only resist any corrosion likely to occur but have the added advantage that they will resist shocks much better than will rigid linings. Linings can be fitted in large ducting for carrying acid gases, such as sulphur dioxide. In this case either hard or soft rubber is employed according to the service conditions.

Rubber hose is also widely used in the chemical and allied industries, and hoses are manufactured for the conveyance of acid, air, steam, water, paints, etc.

Ebonite

Ebonite or hard rubber is exceptionally resistant to corrosion and, at temperatures up to 60°C., the only reagents which markedly attack the material are strong oxidising agents. It has an increasing range of applications. For instance, it can be combined with neoprene and the high styrene butadiene copolymers to meet an even wider range of specific requirements than formerly and at a competitive cost. Ebonite is, therefore, used extensively in the chemical industry for the lining and covering of vessels of all types in centrifuges, pumps, filters and siphons, and for the manufacture of buckets, ladles, stopcocks, pipes, etc. Dependent upon the severity of the conditions likely to be met, the thickness of hard rubber for lining materials is usually from $\frac{1}{8}$ to $\frac{3}{4}$ in. It is highly resistant to moist chlorine, and may be used with confidence for the transport of acids or alkalis, especially where a change from one to the other may be necessary, as the non-porous surface of the lining allows for easy cleaning of the tank between the loads.

An impressive instance of the durability of hard rubber is the vinegar pump installed in 1886 at the works of Hill Evans & Co. Ltd., London. It went into honourable retirement in 1951 after a working life of 65 years.

[*Courtesy: Liquid-Solid Separations Ltd.*
This 600-mm. hydrocyclone has a lining of abrasion-resistant rubber.

The present-day bright nickel-plating processes require baths lined with a special-quality rubber that will not affect the brightness of the plating. There is a form of ebonite which the makers claim is particularly suitable as a lining for all bright nickel processes. Some special features of this material are that a very high degree of adhesion is obtained to the metal which is due to a chemical union of the clean iron with the rubber solutions used as the junction. The strength of the bond between the ebonite and metal is such that a tension of 1,200 to 2,000 p.s.i. is necessary to break the bond. A similar strength is shown when the bond is under a shear stress. Also this type of rubber is quite flexible and when adhered to metal and used at high temperatures the expansion and contraction that takes place does not cause cracking.

Choosing a compound

The enormous diversity of corrosive substances used in chemical plant today make it clear that there can be no single all-purpose rubber compound adequate for the majority of situations. If, for example, it is essential to protect the liquid from traces of discoloration by iron, a rubber compound with iron-free ingredients must be used. If abrasion is serious then it is important to use a soft rubber with a high abrasion resistance. The fact that impurities are almost always present in chemicals used in industry adds to the complexity of the problem. So much so that the 'foreign' substances may well prove more of a headache from the rubber compounding point of view than the chemicals present in quantity.

For this reason the chemical engineer usually leaves the job of working out the exact specification for the rubber to the rubber manufacturer. He does, however, take great care to provide the rubber manufacturer with a very precise brief which covers in detail all the site and operating conditions as well as the chemicals concerned. The type of information which the rubber manufacturer will expect to receive from a chemical engineer will be on these lines:

(1) *Materials to be handled:* (*a*) concentration, (*b*) precise nature of chemicals, (*c*) degree of abrasion, (*d*) rate of flow, (*e*) whether wet or dry, (*f*) whether contamination or discoloration is a factor to be considered.

(2) *Temperature:* (*a*) normal operating temperature, (*b*) maximum possible temperature, (*c*) cycle of temperature.

(3) *Degree of vacuum or pressure.*

(4) *Constant or intermittent cycle of operation.*

(5) *Degree of possible mechanical abuse.*

(6) *Any other technical information.*

Incidentally the manufacturer should also be consulted on the type of bonding agent to use to secure rubber linings in position. It may, for example, be adequate to use an ordinary rubber cement in a static tank but not in a vessel where there is a pump in operation creating strong currents. This may necessitate the use of a chemical bonding agent. Again, in the case of ebonite, no bonding agent is needed, as ebonite forms a strong bond with the metal

itself. For a good many years manufacturers have approached the problem of compounding in a scientific manner and a great deal of information has been collected and correlated so that the behaviour of rubber in a given set of circumstances can be as accurately predicted as that of metals such as steel.

Improvements in compounding techniques are not, of course, the only factors which have contributed to the increased scope of rubber in chemical engineering. The introduction of new synthetic rubbers, the combination of natural with synthetic rubbers and the creation of entirely new substances by combining natural rubber with synthetic materials have all helped to widen the horizon. One example of the combination of natural and synthetic has already been described in the section on ebonite above. An interesting example of a new product resulting from the chemical combination of natural rubber with synthetic materials, known as *Fortiflex*, is already well advanced in its industrial career. It is fulfilling many useful functions in chemical engineering as well as other branches of industry.

Ancillary uses

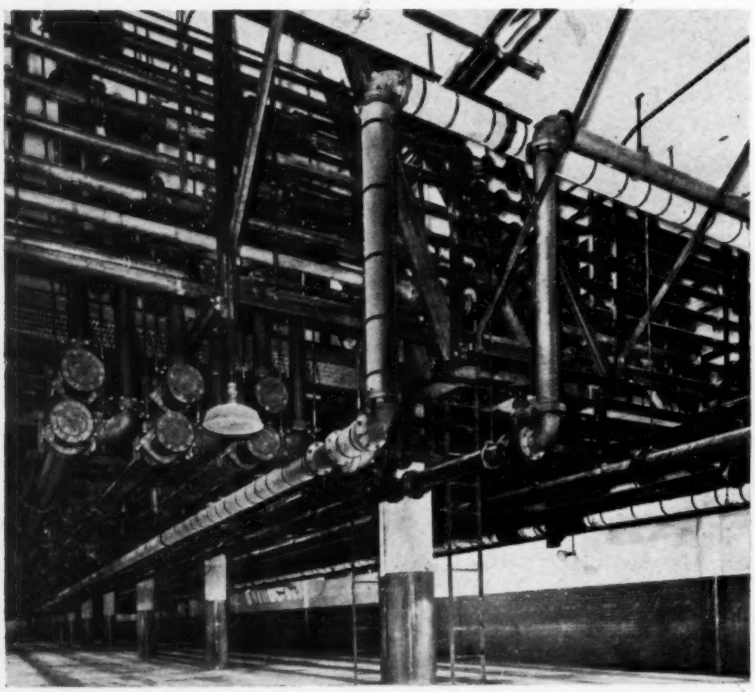
As well as being used in the main defence positions where it is in direct contact with strong corrosive fluids, rubber also has some important secondary functions to perform, particularly in protecting the fabric of buildings and plant.

In any plant where corrosive chemicals are used, there are sure to be areas where it is necessary to safeguard the structure against the effect of corrosive fumes in the atmosphere. This applies to walls, floors, steelwork, extractor fans, machinery, etc. One method of providing the necessary protection is to apply a thin layer of rubber to the surface to be preserved. Another is to use a rubber-based paint. Rubber-based paints like tough conditions and come into their own when the surface is steamy, acid, alkaline or generally unhelpful. Of these paints the most widely used are the chlorinated rubber paints. Unlike oil-based paints, these are immune from attack by caustic or lime and are therefore suitable for use on concrete or asbestos cement. They are chemically inert and because they also possess great impermeability have great resistance to acids, brine and salt. Chlorinated rubber paint can also be combined with zinc dust as a primer for metal surfaces. The range includes paints which are resistant to cold down to temperatures of –60°F. while still retaining their characteristic flexibility. They are therefore ideal for use in refrigerating rooms.

Rubber plays another unobtrusive but important part in the defence against corrosion. In the form of latex it can be incorporated with cement to fix the tiles in effluent ducts, joint the bricks in the pickling tanks and keep the factory floor in good trim.

Turning from the uses of rubber in protecting plant, equipment and buildings, rubber has also an important function in giving personal protection to the men who run the plant. Boots, gloves, whole suits of rubber are worn, and perhaps in the future, as the use of atomic radiation for various purposes becomes more general throughout industry, a complete frogman's outfit may become quite commonplace. Rubber gives protection from secondary radiation and suits of rubber are in use already at atomic plants all over the country.

The uses of rubber extend beyond protection against chemicals to instances where corrosive substances present in the atmosphere or in the water supply make special precautions necessary. An instance of this kind is the borehole main installed by one of Britain's leading motor manufacturing firms. A steel main had become badly corroded after only six months' service by the action of brackish water and similar replacement pipes also failed after the same short time. It was finally decided to install a rubber-lined pipe. It is now possible to report that after six years' service this pipe is still in excellent condition.

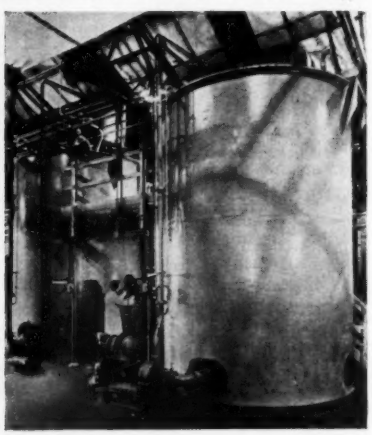


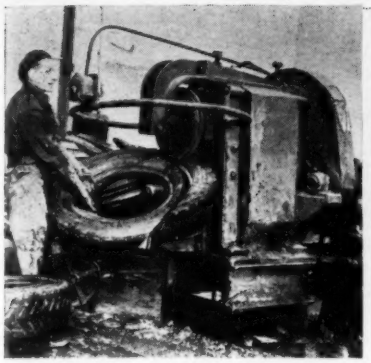
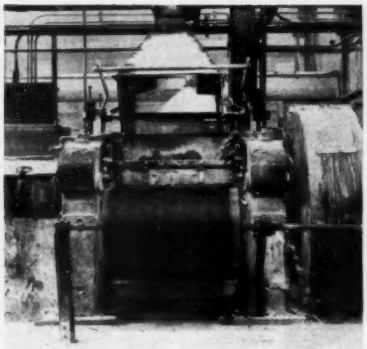
[*Courtesy: American Hard Rubber Co.*

Left: **Over 12 miles of hard rubber-lined pipe were used to carry processing solutions in this rayon plant in the U.S.A. Rubber-protected valves, pumps and tanks are also part of this installation.**

[*Courtesy: Silvertown Rubber Co. Ltd.*

These processing vessels—used in the production of antibiotics at Boots Pure Drug Co. Ltd., Nottingham—are protected with Silvertown rubber linings.



The Utilisation of Waste Rubber

By W. E. Stafford, A.R.I.C., A.I.R.I.

One of the greatest triumphs of the rubber industry has been the development, with the aid of modern chemical technology, of means for reclaiming waste rubber so that it can be put to further use. This article summarises the progress that has been made in this field and the uses to which reclaimed material can be put.

A FREE-WORLD production of 190,643,000 tyres in 1955,[1] or a total annual consumption of 3 million tons of natural and synthetic rubbers, should convey some impression of the volume of scrap ultimately for disposal. A study of the lectures given at Sheffield University[2] dealing with the utilisation of industrial waste makes it clear that this subject is of national importance and likewise of great complexity. The successful, large-scale employment of recovered waste rubber has been characterised as being amongst the major developments of the industry.[3] There is no doubt that the discovery of vulcanisation in 1839 gave the first great stimulus to rubber manufacturing, which, in turn, quickly led to a serious shortage of raw rubber,[4] and by 1850 it was clear that the only practical means of augmenting the latter was by the utilisation of scrap.

Early process—'crumb rubber'

Whilst the use of sulphur and heat, *i.e.* vulcanisation, conferred great improvements in mechanical and other properties, rubber so treated could no longer be masticated on mixing rollers, or shaped under pressure, both of which are basic operations in rubber manufacture. It was this condition, together with the early use of constructive fabrics, such as footwear and belting, which greatly complicated the re-incorporation of waste. The vulcanisation reaction was not readily reversed, though as early as 1848 there was at least one patent with this objective, and, secondly, fabrics were generally difficult to remove. By selecting scrap free from fibres, *e.g.* car springs, or by removing the latter by hand, it was found possible to fine-grind the vulcanised scrap, thereby enabling re-incorporation into mixings prepared on conventional equipment.[5] Some time later (1871) came the use of air blast and flotation, by which means practically all fibres were substantially eliminated. It was by these methods that the rubber industry started to use up its scrap. Between 1860 and 1905, footwear was the largest application of rubber and America was the centre of this branch of the industry,[6] most of which was located in Massachusetts, Connecticut and New Jersey, and it is recorded that by 1870 some 12,000 tons of old rubber boots and shoes were annually collected there and recovered by fine grinding.[4]

Scrap ebonite, a product of rubber vulcanisation using high sulphur ratios, was likewise ground and used again, and amongst its earliest applications was the manufacture of buttons.

Pictures above show (*left*) removal of beads from tyres before cracking; (*centre*) a refining mill and (*right*) a warehouse storing finished reclaim.

Rubber crumb today

The use of ground scrap, or rubber 'crumb' as it is widely known, has continued in ever-increasing volume up to modern times and is still expanding. Nowadays, motor tyre treads constitute the principal raw material and applications are extremely diverse, including soles and heels, accumulator cases, joint seals, carpet underlays etc. Crumb has taken its place as a specific standard material for rubber compounding and is recognised as conferring certain economic and technical advantages.[7, 8] Likewise, ground ebonite scrap is almost a classic addition in many new formulations, since it reduces shrinkage in cure, assists moulding, and restricts the total exothermic heat of vulcanisation.

Reclaimed rubber

The difficulties in production and the somewhat limited use of ground scrap, no doubt stimulated reclaiming, by which is inferred the elimination of all constructive fibres and tramp contamination, together with a restoration of sufficient plasticity to admit of intimate blending with raw rubber. Starting around 1860, reclaiming has provided by far the greatest means of scrap rubber utilisation, and its importance is amply demonstrated by the American usage over the past 40 years, which has fluctuated from 20 to 67% of that of new rubber.

In 1858 L. H. Hall[9] discovered that the exposure of vulcanised scrap to live steam at higher temperatures, and for longer periods of time than is normally used for vulcanisation, induced a measure of replasticisation. Since that basic invention, ' the history of rubber reclaiming has been one of relatively frequent major revisions, keyed to the changes in the rubber-goods manufacturing industry.'[10] The growth of reclaiming is well demonstrated by the following statistics:

	Tons
1861 American only	1,000
1952 World-wide	650,000
1975 Estimated world-wide ..	1,250,000

Most of the scrap footwear of the late 19th and early 20th centuries was reclaimed by the successive processes of disintegration, followed by boiling in dilute sulphuric acid to destroy fibres, neutralisation and washing, replasticisation of cured rubber in live steam, drying and final sheeting on friction rollers. By this time the recovery of rubber had become an established business and several large companies had specialised in scrap collection, sorting and grading.

The rise of the motor industry led to an enormous expansion in rubber production and an ever-increasing volume of discarded motor tyres, tubes and miscellaneous rubber parts became available for reclaiming. The alkali recovery process (1899) [11] employed dilute caustic soda under pressure, thereby destroying fibres and plasticising in one operation. To this was quickly added the use of strainers to remove the last traces of hard flecks of foreign matter, and of refining mills, consisting of close-set friction rollers, by which means the end product was rendered more plastic and homogeneous. The new process, together with other refinements, was extremely well adapted for old tyres and tubes of the motor vehicles and provided a quality of reclaim vastly superior to any hitherto available. This practice was set up in many countries of the world, and with frequent improvements, it remained pre-eminent for nearly half a century. The figures quoted below are illuminating:

Usage	*Tons*
1883-1912:	
Raw rubber	1,200,000
Reclaim (500,000 tons at 60% rubber)	300,000
	1,500,000
1913-1937:	
Raw rubber	13,000,000
Reclaim (5,000,000 tons at 60% rubber)	3,000,000
	16,000,000

Position of reclaim today

Great strides have been made in reclaiming methods and large plants, handling well over a hundred tons of scrap per day, are already sufficiently mechanised for the possibilities of automation to be explored. Whilst the handling of scrap arising from synthetic elastomers has certainly complicated reclaiming, on the other hand it has increased the value and the scope of the industry.

The usage of reclaim is extremely broad, though almost entirely confined to rubber manufacture, and motor tyres, tubes, matting, cycle tyres, soles and heels, battery cases, belting, hose, cements and adhesives are but a few of the principal applications. Whilst it has been described as providing a large source of cheap rubber hydrocarbon, it is solidly fixed in the economy of rubber manufacturing and reclaimed motor tyres, containing about 60% rubber, normally sell at about one-third the price of virgin material. Apart from price advantage, however, the use of reclaim is also identified with certain well-established technical benefits, and in the great slump of 1932, America used 77,000 tons of reclaim, representing 23% of the new rubber consumed, the former being sold at roughly 25% higher price than the latter.

Recovery of fibres from scrap

The recovery of fibres, completely free of rubber, is to the best of our knowledge not yet completely solved. However, certain procedures have been devised which mechanically separate them in a usable condition, leaving the rubber substantially free of fibre for further treatment.[12]

Direct use of scrap

One of the earliest uses of cured waste was admixture with coal-tar and asphalt for road-surfacing compositions,[13] a process even yet in development. Some products are prepared from scrap largely by cutting up, so enabling smaller articles to be fabricated. These range from boat fenders and poultry feeding troughs to shoe soles and aprons, using amongst other types of waste, old tyres, inner tubes, rubber gloves and hot-water bottles. Link belts are made by slicing scrap such as tyres and belts and threading them on to wires.[2]

Scrap as a chemical raw material

A unique and possibly important new development has been described recently.[14] Cured waste rubber is suitably reacted with certain unsaturated compounds containing an electrophilic group, such as carboxyl, and which is α to the double bond. By these means it is possible to produce elastomers having enhanced properties of oil resistance and capable of very wide specialised applications.

The use of vulcanised scrap for the production of chemically modified rubbers, *e.g.* chlorinated or cyclised, or hydrogenated to yield fuels and lubricating oils, has been proposed and patented.

F. N. Pickett[15] has described the possibilities of utilising waste rubber by distillation, thereby obtaining such fractions as rubber solvent or motor fuel (boiling point 70 to 140°C.), oil for reclaiming (boiling point over 170°C.), together with rubber softeners, drying oils, turpentine substitutes and lubricating oils, as well as active char from the residues. The presence of sulphur compounds in the distillates was a complicating factor and the process has not yet developed into regular large-scale production.

Conclusion

The use of waste rubber dates back almost to the discovery of vulcanisation in 1839. It has passed through the successive stages of first fine-grinding fibre-free waste, then waste from which the fibre had been mechanically removed, and finally to reclaiming. All other applications are relatively minor. As yet much shoddy still remains unused and so constitutes opportunity for technical initiative and capital.

The writer wishes to thank the directors of The Rubber Regenerating Co. Ltd. for permission to publish this article.

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Handling Bulk Latex at Singapore

WHILE the production of synthetic rubber is dependent on the resources of modern chemical technology, the production of natural rubber is no longer the simple matter it was in the early days of the industry, and today's compounding and vulcanising techniques, for instance, call for chemical and engineering skill of a high order.

In Malaya the bulk handling of latex from the plantations poses substantial problems of transport and handling, as at the Dunlop Rubber Co.'s 13 plantations, which produce over 750,000 gal./month of latex for bulk transportation and export. Raw latex after being received at each estate factory is prepared for shipment by treatment in centrifuges. These units, operating in a single stage, increase the rubber content of the latex from 35 to 60% rubber solids in the product for shipment, the reject material being coagulated to form low-grade sheet rubber.

Although each tapper adds a few drops of ammonia when tapping, the centrifuged material requires further treatment and the latex is passed from the collecting tanks to ammonia treatment cells, usually by gravity but under compressed air when required. After treatment, the latex again falls by gravity or is pumped into road tankers for transport to the nearest rail head.

The individual estate requirements for compressed air are thus variable, but the total number of compressors in operation on the estates and at the Singapore installation harbour totals 35 including 15 used for providing starting air for power house and pump station engines.

Transport from the rail head is in two sizes of tankers operated by the Malayan railways. The tankers are lined with bitumastic paint and carry 3,500 and 7,000 gal. respectively. The storage installation at Singapore consists of 50 horizontal, cylindrical tanks each of 20,000 gal., the total capacity being over 1 million gal. The storage tanks are connected to vacuum chambers which create the necessary vacuum to draw the bulk latex along the pipelines.

As the installation is located on a level site, large volumes of compressed air are required to push the latex through pipelines to the ship's tanks. Typical units employed are the class TB10 × 9 horizontal single-stage compressors produced by Consolidated Pneumatic Tool Co. Ltd., these being slow-speed, double-acting, water-cooled units.

Among other compressors employed on the estates are the vertical, single-acting, single-stage class P7—D.B. compressors delivering 90 cu.ft./min. at 100 p.s.i. The units are fitted with constant-speed unloaders for continual operation, so that when the maximum discharge pressure is obtained, the unloader opens and passes air under pressure to diaphragms above the inlet valves, holding the valves open and permitting the compressor to operate without delivering air. Compression at full capacity is resumed when the pressure drops to a predetermined minimum, and the unloader is automatically closed. At the Singapore bulk handling installation, air inlet and exhaust pipes are 5 in. internal diameter, whilst suction pipes for creation of vacuum in reception tanks are of two sizes—mainly 2 in. and 3 in. diam., according to size of compressor used.

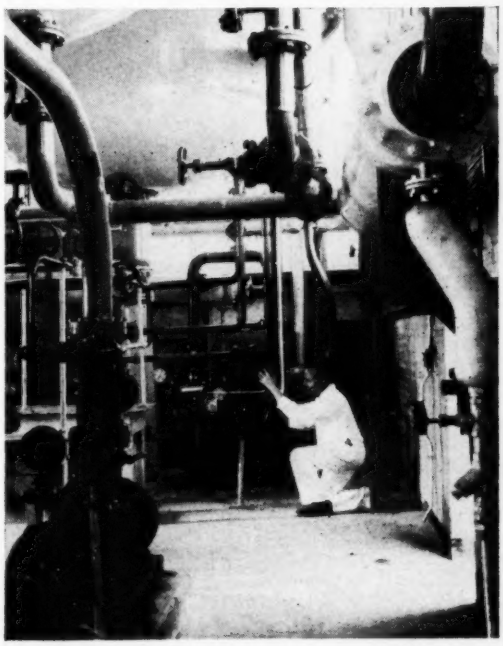
The pipelines along which the latex travels are 6 in. internal diameter, except for the discharge into the reception tanks, where the diameter is reduced to 4 in. The flow is controlled by valves, a large number of which are in use. The most satisfactory for the purpose have been found to be Glenfield heavy-duty, 6-in., cast-iron gate valves and are a standard type produced by Glenfield & Kennedy Ltd., of Kilmarnock. Air manifolds are 3-in.-bore steam pipe with 2-in. branches to each tank. Most of the air valves and three-way cocks are of local manufacture, but a number of Milliken valves are also in use.

New Capacity for Copolymers

Monsanto's new, all-British plant at Newport, Mon., produces high styrene/butadiene copolymers which find their main use in the footwear industry.

A 4,000-TON plant for the production of *Tred* rubber reinforcing resins, one of the latest units to be commissioned at the Newport factory of Monsanto Chemicals Ltd. during the company's present expansion programme, will make a significant contribution to British production of synthetic rubber and illustrates the degree of 'know-how' now available for such activities.

The resins, hitherto available on pilot-plant scale, are produced from styrene and butadiene, emulsion poly-



Polymerisation section of the 'Tred' plant at Newport.

merisation of the monomers—to form latices—being followed by coagulation, filtering and drying to give the final crumb. Interesting technical features of the plant include:

(1) Use of wooden vats for large storage tanks and certain of the smaller process vessels.

(2) Arrangements whereby, in the event of a major works' power failure, the motors for the agitators of the polymerisation vessels and of the circulating water pumps are supplied with power from the works' emergency diesel generator. The supply of cooling water is also included in the emergency arrangements.

(3) Use of mechanical seals, whereever possible, on pumps and agitators.

(4) The main effluent flow from the plant passes through an interceptor pit where any solid material is removed before entering the works' effluent system.

Sequence of operations

Styrene monomer from Forth Chemicals Ltd., Grangemouth (a company in which Monsanto has a one-third interest), is received in road tankers and discharged to bulk storage tanks in the main works tank farm, to be pumped over to the plant day storage as required. Butadiene, obtained from British Hydrocarbon Chemicals Ltd., also arrives by road and is stored in three tanks. Batch quantities of both monomers are pumped to the polymerisation section as required, using preset flow meters to record the charge.

The latices are produced by batch emulsion polymerisation of styrene/butadiene/water mixtures. Certain reactions are not taken to completion and unreacted styrene and butadiene are removed in the monomer recovery section. These recovered monomers are re-used in subsequent polymerisations.

The polymerisation vessels are made of stainless steel and are jacketed.

The latex storage capacity consists of several wooden vessels equipped with slow-speed agitators. Equipment is available for the preparation of any necessary additives, which are added to the latices in these tanks. The latices are pumped to the coagulation sections or to a drum-filling point as required.

Two types of resin

One type of resin manufactured is *Tred* 50—a pale fawn, rubber-like material. The latex is pumped from one of the storage tanks to further agitated tanks in which it is coagulated. The resulting crumb and serum overflow to a residence tank and then to a *Locker* vibrating screen which separates the serum, which is drained to a storage tank. The wet crumb is washed on the screen and is discharged to a tank in which it is reslurried.

The resulting slurry is filtered and washed in a rotary vacuum filter from which it emerges as a wide thick sheet. This sheet is discharged from the rotary filter, cut into lengths by a pneumatically operated cutter and reduced by a shredder to crumb size. The crumbs are discharged to an elevator which feeds them to a band drier. The dried crumb passes into a finished product hopper from which it is packed into 45-lb. multiwall paper sacks and palletised for shipment.

In the case of *Tred* 85—a white granular resin—the latex is first pumped from one of the storage tanks to the coagulating section, and the coagulated latex overflows to a residence tank from which it passes to a batch filter. The serum is removed by vacuum and the granular residue washed with water.

The moist resin is raked out on to a conveyor and elevated to an intermediate storage hopper which feeds a rotary drier. After passage through the rotary drier, the dry resin passes through a granulator which determines the particle size of the resin. The finished product is stored in a hopper from which it is packed into 45-lb. multiwall paper sacks and palletised for shipment.

Synthetic Rubber Project for Holland

A synthetic rubber plant with an initial capacity of at least 50,000 tons p.a. is to be constructed at Pernis, near Rotterdam, Holland, for Shell Pernis Chemische Fabrieken N.V.

An announcement from Shell Petroleum Co. Ltd., in London, reveals that the decision to erect this plant has been based on extensive studies of the world future rubber requirements and supply position. Supplies of natural rubber already fall considerably short of total world rubber requirements and it is not expected that the increased total demand can be met from this source.

Shell Pernis Chemische Fabrieken N.V. has developed into a major chemical production centre since the war. The site of the new plant has been chosen for its advantages in respect of accessibility to shipping and the supply of raw materials.

British Standards

Bursting discs (B.S. 2915: 1957, 6s. net, 'Domed metallic bursting discs and bursting disc assemblies'). This standard deals with bursting disc assemblies in which a circular disc of ductile metal foil is gripped uniformly round the periphery and is caused to bulge by fluid pressure so that it assumes a spheroidal shape. In forming the bulge, the metal of the disc is stretched and thinned increasingly towards the centre and, when a predetermined pressure is reached, the disc bursts by tearing from the centre.

Section 1 of the standard specifies requirements for the metal foil of which the discs are made. Section 2 deals with bursting discs. Sections 3 and 4 deal with disc holders and vacuum supports. Section 5 specifies the adoption of a coding system whose object is to prevent the inadvertent fitting of an incorrect bursting disc.

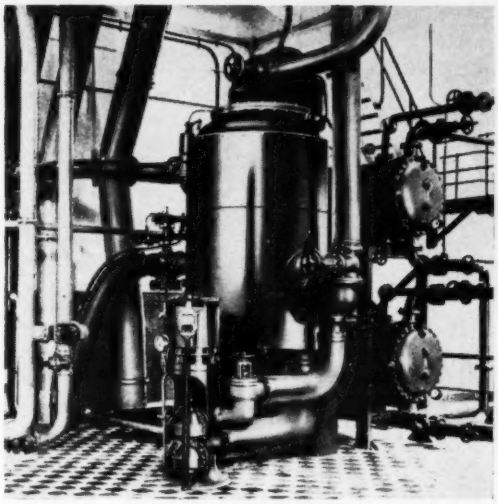
Examination of butt joints (B.S. 2910: 1957, 8s. 6d. net, 'General recommendations for the radiographic examination of fusion-welded circumferential butt joints in steel pipes'). This 45-page illustrated publication relates to the radiographic examination of fusion-welded circumferential butt joints in steel pipes in thicknesses up to 4 in. (101.6 mm.) using the single-wall technique, or 2 in. (50.8 mm.) using the double-wall technique. The recommendations assume the complete radiographic inspection of the welded seam, but they apply equally where only small sections, *e.g.* spot checks and radiographs of repaired sections, are to be examined.

Low-density polythene rod (B.S. 2919: 1957, 3s. net). This new standard has been prepared primarily to meet industry's need for a rod to be used in conjunction with low-density polythene tubes and with low-density polythene sheet, for which a standard is now being prepared. The new publication specifies both black and natural polythene rod and provides for two grades with different metal flow indices. Requirements are specified for diameters and tolerances, as well as for physical properties.

Hydrochloric solutions (B.S. 976: 1957, 7s. 6d., 'Density-composition tables for aqueous solutions of hydrochloric acid'). This new edition of a standard has 16 tables based on the International Critical Tables giving density in g./ml. of the aqueous solution, mass in grammes of HCl in 100 g. of aqueous solution, and mass in grammes of HCl in 1 l. of aqueous solution.

New Paths in SEA-WATER DISTILLATION

By A. E. Williams, Ph.D., F.C.S.



[Courtesy: G. & J. Weir Ltd.

Fig. 1. A typical example of a Weir 'Optimum' de-aerator in an overseas power station.

THE distillation of sea water was first undertaken on a commercial scale in connection with sea-going craft making long voyages, and today the majority of vessels carry some means of obtaining fresh water from sea water. Where the vessel is driven by steam, the provision of fresh water is often associated with the de-aeration of feed water for the boilers. Recent years have witnessed considerable development of sea-water distillation on land-based sites, generally on or near the coast. Such plants are of value where adequate supplies of fresh water are not available from rivers, etc., and enable an increasing population to receive a normal fresh-water supply although there may be little, if any, naturally available in the area.

In the majority of sea-water distillation plants the evaporators can operate efficiently on low-pressure steam, such as is available from back-pressure or pass-out turbines. These turbines are not commonly used in conventional power stations—where the condensing turbine is the standard unit—but many private firms generating their own electricity frequently make use of these specially designed turbines to ensure a cheap supply of process steam. In other cases, waste heat from the exhaust gases of diesel engines, oil refineries, and steelworks waste heat may be harnessed to provide the low-pressure steam, or to heat the evaporators directly. Whenever such waste heat is at hand, the distillation plant becomes a very economical unit. While sea-water distillation has been carried on for the most part using conventional types of evaporators, experience in operating the plants has led to certain improvements being made in recent installations. In land-based plants the advantages of the multiple-effect evaporators are put to use, but on board ship, where space is a consideration, the evaporator is seldom more than a double-effect. The use of vapour compression can effect economies both in the cost of distilling and in plant space, and this technique is particularly applied to marine installations.

De-aeration

An example of the provision of a combined supply of fresh water for domestic use and boiler feed water from sea water, in which de-aeration processes are to be used, is represented by a large order placed with a British company[1] for an evaporating and distilling plant to serve the Clifton Pier power station of the Bahamas Electricity Corporation. This installation, due to be completed in August 1959, embodies two independent units, each producing over 500,000 gal. of fresh water daily for domestic use, and a small quantity for supplying the power station boilers with de-aerated feed water.

The equipment will be made largely of *Colclad* stainless steel, to a new design, and fabricated on the site. Each plant will have a main structure 32-ft. high, with internal compartments to form an eight-effect evaporating plant of the submerged-tube type, which has been found to be both economical and efficient. Sea water will be pumped to the evaporators at a rate of 280,000 gal./hr., against a head of 20 ft. Steam at a pressure of 12 p.s.i. absolute and with a temperature of 200°F. will be supplied at a rate of 35,500 lb./hr., distillate leaving the condensers at 120°F.

By circulating the sea water through heat exchangers it reaches the first-stage evaporator at a relatively high temperature, and the continuous flow of brine through the various stages ensures maximum heat transfer. The vapour from the first effect will provide the heat for the second and subsequent stages in series, the brine from the final stage going back to the sea, and the vapour to the distilling condensers. Chemical treatment of the phosphate type will be used to retard scale formation on the heating elements and provision will be made for 100% scale prevention should this be considered necessary at a later date. Scale formation and corrosion in the plant are appreciably lowered by the use of a closed feed system for the boiler plant, and the use of de-aeration equipment (Fig. 1).

A regenerative steam condenser is now generally incorporated in steam power plants, and it functions in conjunction with a closed feed system between the condenser and the boilers. In this type of condenser a reduced pressure is obtained by the use of one or more air ejectors; thus the water is subjected to both heat and a pressure lower than that of the atmosphere, and these two features combined rapidly eliminate any dissolved gases. The condenser is designed to produce a relatively high vacuum under a given set of conditions. Condensate is delivered at the temperature corresponding to the vacuum and, as there is no temperature drop, the maximum

thermal efficiency is obtained. Since the expelled gases are cooled efficiently, the vacuum apparatus can operate with a corresponding high efficiency. Even in the most efficient power plant it is necessary to introduce into the system a small proportion of make-up water, and the latter generally enters the system *via* the regenerative condenser, so that it can be de-aerated before passing to the boilers. In some cases the make-up water may be heavily loaded with salts, as with sea water, which could cause a lot of trouble, particularly in high-pressure boilers. This problem is solved by always using distilled water for make-up, and on board ship it has become standard practice to use double distillation plant for creating a supply of make-up water from sea water. A similar arrangement is made for land-based installations whenever sea water or other water heavily loaded with mineral salts is concerned. Generally speaking, a well-designed regenerative steam condenser will reduce the oxygen content of the feed water to a point between zero and 0.02 ml. per litre of water. In this respect the condenser is slightly more efficient than a separate de-aerating unit. The latter is normally arranged in the feed-water system between an open feed vessel and the boiler-feed pump, and thus functions also as a heater to the feed-water system. Exhaust or other low-pressure steam may be used in the de-aerator, and all heat employed is absorbed and retained in the feed water.

Flash evaporators

The older type of flash evaporator handling sea water often depended upon specially designed evaporating surfaces for its relative freedom from scale formation. These surfaces were extremely sensitive to fluctuations of temperature, and the rate of expansion or contraction of the surfaces, being different from that of the deposited scale, could be the means of loosening the scale from the surfaces, so enabling any accumulated scale to be quickly cleared from the vessel. An improvement on this is represented by a new design in flash evaporators,[2] and by the use of continuous dosing equipment to treat the water with an appropriate chemical before it enters the evaporator. The latter is a very compact unit, although it embodies a number of flash chambers in one vessel, and the output is high in relation to the size of plant. A typical layout of the plant is given in the diagram, Fig. 2, in which sea water is being circulated by a pump through a series of heat-transfer surfaces, where it is gradually heated by condensing vapour, produced in a number of associated flash chambers. Final heating is normally achieved by an external steam supply in the heat input section. The boiling sea water is then cascaded through the flash chambers which operate at progressively lower pressures and saturation temperatures. In the process some steam is flashed off in each chamber and it condenses as distillate on the heat transfer surface connected to that particular chamber. Heat rejection from the system is usually effected by a separate cooling-water supply to the heat-transfer surfaces operating at the lowest temperature and pressure. Most of the cooling water used there is ultimately rejected, but a portion of it—normally between 200% and 220% of the distillate produced—is discharged as feed into the low-pressure flash chamber. Excess sea water is continuously discharged from the plant *via* a blow-down valve.

When the feed is 200% of the distillate production, the blow-down will be 100% of the distillate made, and the sea water circulating in the evaporator will be concentrated to double the normal concentration of sea water. This is the normal design figure for the plant, except when exceptionally high distillate purities are required; in such cases a higher blow-down ratio may be specified. The distillate derived from each heater is cascaded from stage to stage, being extracted from the last stage by a distillate extraction pump. Normally the condensate produced in the heat input section is also cascaded through the heaters and is taken from the plant together with the distillate. This simple design of plant means that, when an adequate supply of sea water under pressure is available, only sea-water circulating and extraction pumps are required; the necessary reduced pressure in the plant being achieved either through a vacuum pump or an ejector. Where the incoming sea water

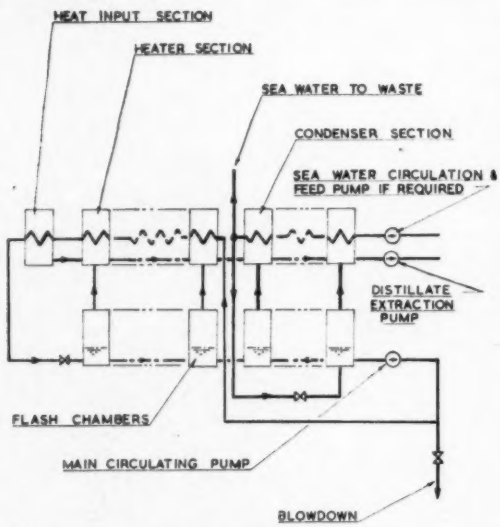


Fig. 2. Flow diagram of a flash-type sea-water evaporator.

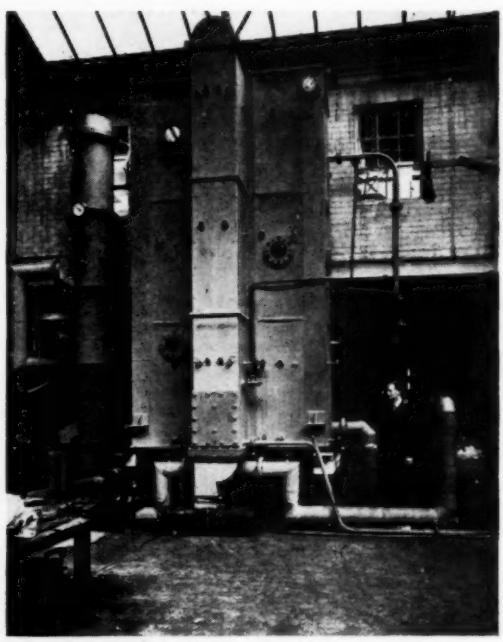
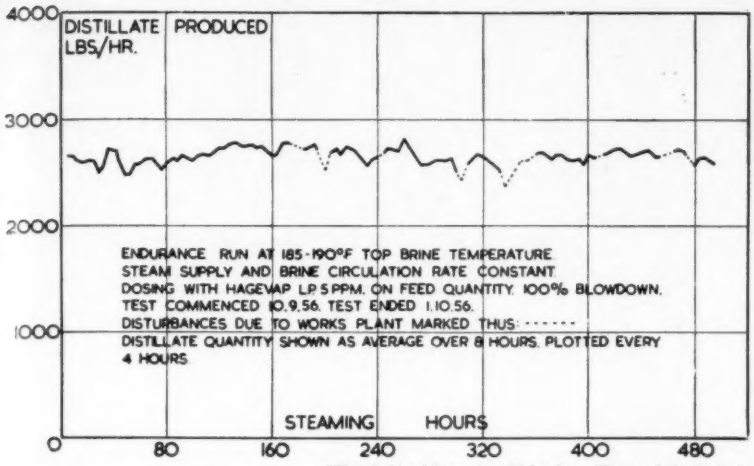


Fig. 3. Heat transfer and scale deposition test plant.



[Figs. 2, 3 and 4, courtesy Richardsons, Westgarth & Co. Ltd.

Fig. 4. Graph illustrating a 500-hr. test run on a flash evaporator.

is relatively free from abrasive material such as sand, the heat-transfer surfaces in the plant may consist of a series of straight aluminium brass tubes fitted to rolled naval brass tube plates; but when abrasive material is present in the water, either adequate filtering is indicated, or abrasion-resistant tubes have to be employed, such as cupro-nickel tubes. The various units of plant such as heaters, flash chambers and water separators are grouped together inside a fabricated mild-steel vessel. In the case of very large outputs, the proportions of the vessel may be adjusted to suit available facilities.

Continuous dosing

In the absence of some form of chemical treatment of the incoming sea water, the heat-transfer surfaces would quickly lose their efficiency owing to build-up of scale, the latter consisting mainly of sodium chloride, with lesser amounts of sulphates, bicarbonates and carbonates of calcium and magnesium. Fortunately, the sodium chloride of itself does not produce scaling nor corrosion of the heating surfaces, scaling being practically entirely due to the other salts present in the water. Methods of scale prevention are, accordingly, not directed towards dealing with the salt in the water, but towards the sulphates and carbonates. Phosphates are the materials most widely employed for dealing with the problem, and these appear on the market under various trade names, but consist mainly of one or more of the following: sodium metaphosphate, disodium phosphate and trisodium phosphate. In applying these to the sea water before it enters the plant, the object is to precipitate the scale-forming salts in the plant and bring the precipitate down as a sludge which is removed through the blow-down.

To investigate on a commercial scale the heat transfer and deposition problems in flash evaporators a full-size industrial pilot plant (Fig. 3) was erected and run for a period on sea water treated with *Hagevap LP* (marketed in Britain by Albright & Wilson), the dosing unit giving a concentration of 5 p.p.m. in the ingoing sea water. Without entirely suppressing the formation of deposits, the treatment was considered to be successful provided that the sea water is not heated in the evaporator above 185°F. The graph, Fig. 4, records the results of a 500-hr. run with a constant steam supply, constant water circulation, and a maximum sea-water temperature of 190°F. While this operating temperature is a little higher than the recommended one, it does not imply a sharp deterioration if it is not exceeded. When the temperature is raised to 200°F., test runs show that there is some deterioration after 100 hours' working, but only in the hottest tube pass. Even at 215°F. it took 20 to 30 hours' running to detect deterioration in the heat input section, but tests indicate that the flash evaporator is not very sensitive to occasional excessive sea-water temperatures. In practice it may be feasible to run such an evaporator up to 195°F. and so increase output by about 10%.

The dosing chemical used on the test runs produced only a very slight deposit, less than 1 mil in depth, providing the working temperature was not unduly high. This thin deposit can be simply washed off the surfaces, since there is no appreciable adhesion, and this operation may be carried out while the evaporator is working. A simple type of moisture separator has been developed suitable for the flashing chamber design used.

With the flash evaporator plant the foregoing arrangement of units is quite adequate to produce normal drinking-water supplies from sea water, and also feed-water supplies for low-pressure boilers. Where high-pressure boilers are concerned, however, a differently designed separator is required which will give distillate purities containing not more than 5 p.p.m. dissolved solids. Where feed water to high-pressure boilers forms only a part of the total output of the plant, a separate condensate extraction pump may be arranged to extract the pure condensate from the heat input section without mixing it with the bulk of the distillate being produced. Such a plant may also be modified to give a proportion of the distillate stream as double distillate, in which case very high purities can be obtained. The evaporator itself can be operated with steam at a pressure as low as 11 p.s.i.abs.; steam at a somewhat higher pressure is needed to operate an air ejector, but where such steam is not available, a vacuum pump may take the place of the ejector.

Coil evaporators

In certain circumstances coil-type evaporators may be preferred to other designs such as flash, forced circulation or submerged calandria, for the coil unit is considered to have the advantage that it enables much higher operating pressures to be employed when handling sea water abnormally high in calcium and magnesium contents, and the coil facilitates cleaning by scale cracking. An example of this type of plant occurs in an installation[3] connected with a water supply scheme for the State of Qatar, in the Persian Gulf. In this area the chloride concentration of the sea water is around 24,000 p.p.m., while the calcium and magnesium contents together total over 2,000 p.p.m., which considerably increases the liability to scaling when compared with a normal sea water. Since oil fuel is available in abundance at a low price, the triple-effect evaporators are heated with steam at 100 p.s.i., supplied by oil-fired boilers. Not only do the coils facilitate cleaning by scale cracking, but they are so fitted that they may be taken out, inspected and replaced within 12 hr. (See Figs. 5 and 6.)

Useful by-products

In all the various methods for the distillation of sea water a fairly strong concentration of brine is produced, which is always put back into the sea and so is lost, although it represents a good raw material for the recovery of its different constituents. Whenever these constituents are recovered from sea water, the first step is concentration of the water. By combining distillation with recovery techniques, both phases of activity could be made far more economical.

On board ship, owing to space limitations and lack of skill in this particular direction, it is not feasible to process the concentrated brine further with a view to recovering chemicals, but no such limitations are imposed on land installations. Many of these could usefully incorporate additional plant for the recovery of these materials.

For example, the Dow Chemical Co., at a plant in Texas, make use of a submerged combustion process[4] for the recovery of sodium chloride, the product being sold as ' sea salt.' Until recent years difficulties were experienced in obtaining anything like pure sodium chloride from sea water, due to economic problems met with in separating one salt from another. An advance in this direction has been made by the Russians,[5] who found that high-purity salt (NaCl, $2H_2O$) can be crystallised from a brine concentrated to a suitable density. Where the impure brine obtained from sea-water distillation is not sufficiently concentrated for crystallisation purposes, further evaporation is undertaken by the use of waste heat from power stations (flue gases), or oil refineries, to effect the required concentration economically.

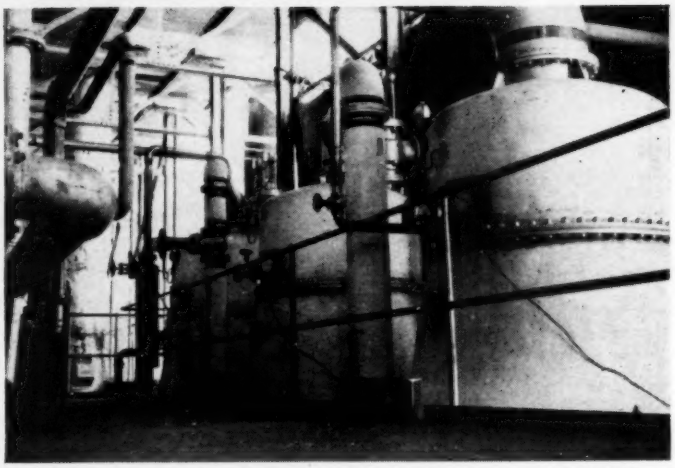
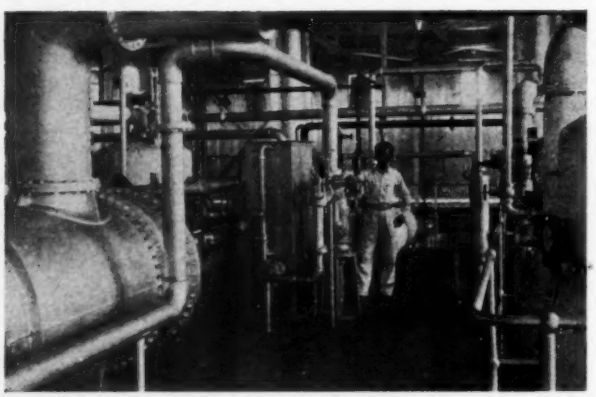


Fig. 5. One set of the triple-effect evaporators of a sea-water distillation plant at Qatar in the Persian Gulf.

The recovery of potash and other potassium compounds from sea water has formed the subject of much experimental work. At Amsterdam an experimental factory has been in operation for several years, producing about 30 tons of products weekly, in which potassium is precipitated as its dipicrylamine salt. Similar plants are in course of construction in other European countries. These plants operate the Kielland process, which depends on the precipitation of the potassium salt of a highly nitrated amine. This is separated as a moist crystalline mass from which potassium nitrate is formed by treatment with nitric acid, the nitrate being used in fertilisers. A process for the production of sodium bicarbonate from sea water, using ion-exchange resin, has been developed by the Asahi Glass Co., Yokohama.[6] Bromine recovery is also a practical proposition by the use of the Dow process, based on the air-stripping of acidified and chlorinated sea water. An alternative method of bromine recovery is the Kubierschky process, involving the distillation of chlorinated brines of suitable bromine content.

All such recovery processes make use of concentrated sea water, and the partly concentrated liquid leaving the evaporators in the process of sea-water distillation represents a useful product as a raw material for such processes. It is obvious that a small chemical plant operated in conjunction with a sea-water distillation plant would not only lower distillation costs but would enable production costs of those particular chemicals to be sufficiently low to compete with chemicals made by other methods.



[Figs. 5 and 6, courtesy Bennett Sons & Shears Ltd.

Fig. 6. First-effect end of Qatar sea-water distillation plant with operator at the side of the ejectors. The main condenser can be seen on the left.

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[2]Richardsons, Westgarth & Co. Ltd., Wallsend-on-Tyne.
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[4]U.S. Pat. 2,606,839.
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[6]*Res. Rep.*, 1952, **2,** 148.

Crosfield's training scheme

A new training centre, intended to answer the need for specialised training to match the present advances being made in manufacturing methods and factory organisation, has been opened by Joseph Crosfield & Sons Ltd. It will provide a centre for all phases of employee training, from first apprenticeships, through routine refresher courses, to leadership and promotion classes.

Electrolytic Polishing of Stainless Steel

By P. F. McKinney, D.F.C.
(Electropol Processing Ltd).

This article describes an electrolytic method of polishing stainless steel, as opposed to mechanical polishing, which is of great interest to the chemical and allied industries. This method is claimed to produce a new type of surface finish which not only gives increased corrosion resistance and cleanliness, but also reduces costs and gives greater freedom at the design stage.

TWO of the major problems confronting both designer and user in the many industries where stainless steel is used for technical reasons are those of corrosion attack and the avoidance of surface adhesion. This is particularly true of the large-scale manufacture of chemicals or by-products, where the regular dismantling of plant for cleaning is so costly.

Many firms have attempted to combat these problems by the use of mechanical polishing, either in the initial stage of manufacture, or after fabrication, as a final operation. This method has, however, shown certain disadvantages, not the least being the extreme cost of mechanical polishing. In recent years electrolytic polishing has come into prominence as an attractive alternative and tremendous strides have been made in this field. The particular process to be dealt with in this article is the *Electropol* process, by means of which stainless-steel articles of all sizes and shapes, including 1,500-gal. tanks, can be satisfactorily polished. Among items that have been successfully treated by this method are heat-exchanger plates; filter plates used for chemicals, drugs, beverages, etc.; stainless-steel valves, bellows and pumps; pipe and tube for the aircraft and other industries; and many different sizes and shapes of tanks for the atomic energy, food, dairy, photographic and chemical industries, etc.

The process

The process is electro-chemical, the stainless-steel article being jigged and then immersed in a chemical bath and subjected to an electric current; a controlled amount of metal is removed from all surfaces *evenly* so that the shape and design of the article is unaltered. The process is therefore one of 'de-plating' and, in the case of good quality, cold-rolled, softened and descaled material, the amount of metal removed is in the order of 0.0005 in. in normal polishing.

Two 600-gal.-capacity 18/8/3-type welded stainless-steel tanks which have been electro-polished on the internal surfaces only. These were processed for Kodak Ltd. for use involving photographic chemicals.

Increased corrosion resistance

It has been conclusively proved by exhaustive field tests in many branches of industry over the years that stainless steel electrolytically polished has a corrosion resistance at least equal to that of top-grade mirror mechanical polishing and, of course, superior to any lesser degree of mechanical polishing. Some of the reasons for this greatly increased corrosion resistance can readily be appreciated when it is realised that stainless steels contain metallic and non-metallic inclusions which have been unavoidably introduced during manufacture, in particular in the rolling-mill stage. Mechanical polishing not only fails to remove such inclusions but tends to push them further into the surface and possibly even increase them by further 'pick-up' and, eventually, they become points of corrosion. By the action of electro-polishing, such surface inclusions are removed and a chemically clean surface is left.

Chemical and hygienic cleanliness

In the case of chemical, food, dairy and hospital equipment, it is absolutely essential that the surface of the steel from which articles for these industries are fabricated should at least start by being chemically clean and should not have subcutaneous cavities and imperfections which could harbour bacteria and cause corrosion. By the smoothing out of the surface and the removal of impurities, as described in the preceding paragraph, electro-polishing ensures that the component is left chemically and hygienically clean.

Resistance to surface build-up

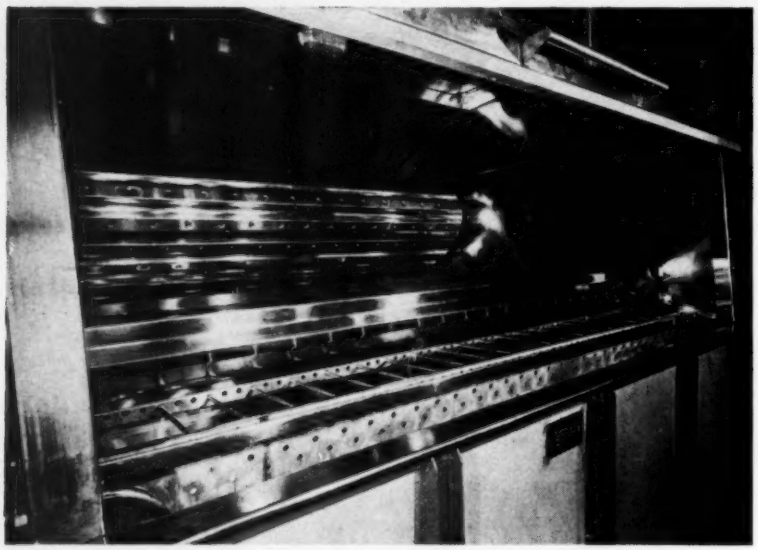
The characteristics of an electro-polished surface are such that there is less tendency for liquids and/or solids to adhere to it, which has been amply illustrated in a number of applications, as for instance in the photographic industry, where large numbers of stainless-steel emulsion containers are

used and where it is essential that the emulsion does not stick to the surface. This property is of immense value where 'cleanability' is concerned, in other words, when it is necessary, after a batch or process in manufacture, to clean the surface of a stainless-steel article, vessel or container so that no residual products are left behind.

For example, electro-polishing was found to be the only satisfactory method of treating the surface in the dyeing industry, where no traces of dye must remain in a vessel when another batch is to be prepared and, more especially, where there is to be a colour change. In chemical and laboratory processing and particularly in the case of large vessels which are used for the manufacture of plastics, electro-polishing is the only truly satisfactory method, otherwise, owing to the build-up which occurs during manufacture of the product, it is necessary to break down the plant and spend a considerable amount of money on cleaning the sides of the vessel by mechanical means, apart from the loss of usage of the vessel whilst such action is taking place.

Standard of finish

Apart from receiving all the technical advantages mentioned above, the stainless-steel article is, at the same time, polished, and it must be understood that this polish is an entirely different one from that obtained by mechanical means, but, in many cases, is probably of a more lasting nature than that of the much more expensive mechanical method.



A batch dyeing machine manufactured and electro-polished by Leemetals Ltd. With a heated dye machine of this type the internal surfaces are subjected to a saturated steam atmosphere and the increased corrosion resistance obtained by electro-polishing is shown to advantage in this application.

Applications in the chemical industry

Certain specific applications of the successful use of electro-polishing by the *Electropol* process have already been mentioned above, but as practically any component fabricated from a stainless-steel alloy can be satisfactorily electro-polished, it will be readily appreciated that there is no limit to the applications.

Apart from dyestuffs, photographic materials, etc., a large amount of work has and is being carried out for the Atomic Energy Authority, one recent example being concerned with explosive plant, where batch production was involved, and the avoidance of any foreign bodies in the surface of the processing tanks was vital. Another important application in this field is, of course, electro-polishing to avoid contamination.

Finally, in the case of large chemical manufacture, it cannot be too often stressed that electro-polishing of the surface obviates the costly necessity of breaking down the plant for regular cleaning, which would otherwise be necessary if mechanical or other means of polishing were used instead.

It will be readily appreciated, therefore, that electro-polishing offers distinct technical advantages to industry using stainless steel. This is perhaps of especial value in the design stage as, in the past, prior to the availability of this technique, designs were limited by the problem of suiting the component to subsequent mechanical polishing. Now the designer can visualise a complex form by the adoption of electro-polishing at the end of a manufacturing cycle, which not only saves cost but frees design.

Sucrose esters

Howards of Ilford Ltd. announce that they are now manufacturing, under licence from the Sugar Research Foundation, a range of the sucrose or sugar esters.

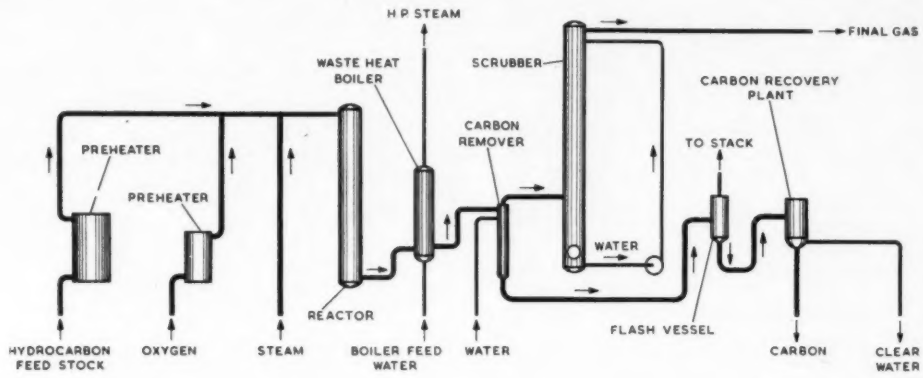
Sucrose esters are non-ionic surface-active agents which have important applications as non-toxic emulsifiers in all sections of the food industry and in cosmetics, pharmaceuticals and animal feeding stuffs and as detergents, particularly in the textile and allied trades.

Current estimates in the U.S., where the processes have been developed for a little over two years, hint at the consumption of sugar esters reaching 200,000 tons p.a. when fully established. While U.K. authorities look upon these figures with very much reserve there is, nevertheless, a conviction that the scope for these esters is considerable.

Stainless welded tube

A British firm have commenced production of stainless material in welded tube form, and the first runs will be made in *Metior* 1 (18/8) quality. A further development, state Talbot Stead Tube Co. Ltd., is the supply of drawn welded tubing which is achieved by certain draw-bench passes after the welded tubes have been produced from strip. By this means intermediate sizes of tubing can be manufactured. Low-pressure equipment under corrosive conditions is also expected to utilise stainless-steel tubing of these qualities, and Talbot Stead expect to be able to offer their *Metior* 2 (18/8/Ti) and *Metior* 6 (18/8/Mo) qualities in the very near future.

Shell Gasification Process



THE SHELL GASIFICATION PROCESS

A RECENT announcement by the Woodall-Duckham Construction Co. Ltd. brings into prominence the Shell Gasification Process *which will be incorporated in plants to be made available by W-D. Some details of the process are given here.*

The *Shell Gasification Process* was developed in Holland by the Royal Dutch/Shell Group of Companies. It is based upon the continuous, non-catalytic, partial oxidation of liquid or gaseous hydrocarbons to produce a gas high in hydrogen and carbon monoxide suitable for use in synthesis and in the production of gas for town distribution.

The process uses oxygen or oxygen-enriched air and operates at high pressure. Conditions in the reactor can be changed at will to suit the type of hydrocarbon feedstock it is desired to gasify. The process provides for the gasification of a wide range of feedstocks.

Reference to the diagram shows that the principal parts of the plant incorporating the *Shell Gasification Process* are the reactor, the waste heat boiler, the carbon extraction and recovery equipment and the gas scrubber. The waste heat boiler operates continuously in the production of steam at any desired pressure and is readily maintained in operation over long periods without recourse to cleaning. The actual quantity of steam produced is sufficient for use in the process and provides also a substantial quantity for other purposes.

The first industrial *Shell Gasification* plant which was built in Ijmuiden, in Holland, has a gasification capacity of 50 tons/day of heavy oil. It was put into commission in December 1956 and supplies gas for synthesis purposes to the Mekog works.

A further plant is currently being built by Woodall-Duckham Construction Co. Ltd. at the Shell refinery in Shell Haven. It will have a throughput of 200 tons/day of heavy fuel oil and will provide gas for the manufacture of synthetic nitrogen fertilisers.

Low cost of maintenance is among the advantages claimed for this process. The economic attraction of the process, of course, increases with the size of plant and this, while being true for most processes, is particularly so where oxygen plant is involved.

Among other advantages, it is stated, are wide flexibility in the choice of feedstock; recovery as high-pressure steam of substantially all the heat developed by the reaction; highly efficient means for the removal of carbon; easily controlled operation at the desired pressure; and the compactness and simplicity of the apparatus.

Letter to the Editor:

Science Teaching at Universities

DEAR SIR,

In reporting on Dr. R. P. Linstead's 'Hinchley Memorial Lecture' to the Institution of Chemical Engineers in your December issue (p. 460) you comment on my suggestion, made at this meeting, that many science lecturers are not wholly 'civilised.' Perhaps you would allow me to develop my point a little further than I did on that occasion.

Matthew Arnold said that 'civilisation is the humanisation of man in society.' My point is that a technical expert, propounding his specialised knowledge to students, may give excellent scientific instruction while in no way making his audience conscious of the broader context of society—and this has traditionally been one of the prime functions of the university. Isolated scientific knowledge can, all too easily, seem 'inhuman.' To avoid this requires considerable skill, a skill which need not occur side by side with scientific prowess.

Discussion of what non-scientific subjects the student should be taught is vastly complicated by the heavy and increasing demands of science itself on the limited time available in a university course. I believe, though, that in

any case this approach misses the point. What we seek is the balanced scientist who fits into society, who sees his speciality in perspective as only one part of human knowledge and endeavour—in short, he must be 'civilised' in Matthew Arnold's definition of the word. I submit that this 'civilisation,' to use an old teaching phrase, is 'better caught than taught.'

So we come back to the lecturers: how many have this attitude of mind which their students can catch? Or perhaps it is more correct to ask, how many of them make it obvious to their students? Do they not, all too often, teach science in isolation from ordinary life and humanity?

I regard this question as vitally important since the whole trend is for science to dominate society, yet at the same time to become so massive and complex that the student will have no time for non-scientific lectures. If this continues, it could easily happen in a decade or so that other forms of knowledge and human activity are completely subordinated—Orwell's 1984 in fact. The movement must be stopped at the top, that is, with the university lecturers, who have such enormous influence on the rising generation of technologists—whose numbers so much effort is being made to increase.

This eventually comes down to the question Sir Hugh Beaver put, in summing up at Dr. Linstead's lecture: 'Cannot science be taught as a humanity?' My answer is yes—but it is up to the lecturers. In fact, the best of them already do so, thanks to the richness of their own personality. Can it not then be deliberately adopted as a general dynamic policy?

One eminent person who is evidently in sympathy with this plea is Dr. Isidor Rabi, Higgins Professor of Physics at Columbia University, and President of Mr. Eisenhower's Scientific Advisory Committee. Shortly after the launching of the Russian 'sputnik,' the *Sunday Times* sought his views on how the West should react. In answer to one question he said: 'We must teach science not as the bare body of fact, but more as human endeavour in its historic context—in the context of the effects of scientific thought on every kind of thought. We must teach it as an intellectual pursuit rather than as a body of tricks.'

Yours faithfully,

D. B. PURCHAS

2 *The Holt,*
Wray Park Road,
Reigate, Surrey.

Canada's big new chlorine and caustic soda plant at North Vancouver, as seen at time of start-up. Burrard Inlet, in the foreground, provides deep-water transportation for ships supplying crude salt and for barges handling chlorine and caustic soda using rails on deck.

Big New Chlor-alkali Plant for Canada

COSTING $12 million to construct and equip, a new chlorine-caustic soda plant, the first of its kind west of the Canadian Rockies, was inaugurated recently at North Vancouver, B.C., by Hooker Chemicals Ltd., the Canadian subsidiary of the Hooker Electrochemical Co., U.S.A.

The plant

Incorporating more than 700 automatic control and recording devices and employing about 100 personnel, the new plant stands on a 110-acre site and has a rated daily capacity of 110 tons of 50% and 73% liquid caustic soda, 100 tons of chlorine and 1 million cu. ft. of hydrogen, this full capacity to be built up on a gradual basis. Both caustic soda and chlorine will be supplied to pulp and paper manufacturers and to the chemical industry, caustic soda will also be supplied to oil refineries and plywood adhesive manufacturers, while chlorine will be supplied to municipalities using this chemical for water purification and sewage treatment. Salt brine and steam are also sold to an adjacent sodium chlorate plant.

Comprising 12 major buildings of concrete block construction, the plant utilises 70,760 sq. ft. of floor space.

Some 160 tons of bulk, crude solar-evaporated salt are required daily, and this is delivered by shipload from the San Francisco Bay area and other southern points, where it is offloaded at a 500-ft. dock with a minimum water depth of 35 ft. It is stored in three open tanks, each 120 ft. in diameter by 14 ft. high, having a total capacity of 33,300 tons of salt, or almost six months' supply. The tanks are filled by means of five connected belt conveyors which run from the dock to the tanks.

Water and power supplies

About 7,200,000 gal. of water a day are used at the new plant, most of it required for cooling purposes in the large vacuum evaporators used to concentrate the caustic soda. Of this water supply, 5,760,000 gal./day is obtained by the company's own pumping station which draws water from Burrard Inlet nearby. This water is later returned to the inlet in the same condition as received. The balance of 1,440,000 gal. daily is municipal water and is used mainly for drinking and sanitary purposes.

The installed power capacity of the plant is 18,000 kw. and electricity is received from the British Columbia Power Corp. Ltd., a subsidiary of B.C. Electric Co., in the form of alternating current. This is converted to d.c. for cell use by means of mercury arc rectifiers supplied by Canadian Westinghouse.

Hooker cells

Production of chlorine and caustic soda is carried out by means of 116 of the largest and latest model Hooker-type S-3B cells, 29 cells to a row and connected in series. In each cell d.c. electricity is passed through a water

solution of salt, thus decomposing the salt. Chlorine gas is formed at the anode and sodium ions at the cathode. The sodium reacts with the water present to form weak caustic soda and hydrogen gas. The chlorine is liquefied. In this form under pressure, the chlorine is despatched in tank cars either by rail or on barges fitted with rails, or in pressure vessels mounted on barge decks.

The caustic soda is evaporated to either 50% or 73% concentration, and despatched in tank cars by rail or barge, or in barge holds or in tank trailers. A 350-ft.-long ferry slipway provides mooring for the barges.

The hydrogen is currently being used as fuel in the production of steam, but is expected to have more profitable commercial uses at a later date.

Two boilers have been installed, one being kept as a standby, and each having a capacity of 100,000 lb. of steam per hour.

New Books

High-pressure Effects

The highest static pressure yet attained in a laboratory experiment is 4×10^5 atmospheres. This is only about one-tenth of the pressure at the earth's centre and is far smaller than the enormous pressures of stellar physics, which break down atoms into bare nuclei and electrons. Today chemical production processes are operated up to 3,000 atm., but the recent industrial synthesis of diamonds and of a potentially valuable new form of boron nitride, at 100,000 atm. and 2,000°K., point to a large upward revision of this limit.

This book* is an up-to-date account of the study of many physical and chemical properties of gases, liquids and solids at high pressures. To cover so wide a field in a moderately sized volume the author includes only sufficient detailed results and data for illustrative purposes. A list of nearly 600 references assists further exploration of particular topics. Most of the many useful but unilluminating empirical relationships are also avoided. Instead, the pressure effects are discussed as far as possible in terms of equations derived from well-defined molecular models.

This fundamental approach is the particular strength of the book and, while reducing its value to the design engineer in a hurry, will much prolong its useful life.

The arrangement occasionally appears arbitrary and the treatment too summary. The high-pressure polymerisation of ethylene might well have received more detailed consideration, and the various elastic theory formulae for the yielding of thick-walled cylinders are dismissed too perfunctorily. These are small defects in an admirable survey which also makes a stimulating attempt to interpret the novel effects of very high pressures. The book is well written and readable, and chemists, physicists and engineers will find it an indispensable guide to the subject.

K. E. WEALE

**Physico-Chemical Effects of Pressure* by S. D. Hamann. Butterworths, London, 1957. Illustrated. Pp. 246, 42s. net.

Organic Chemistry

' Fieser & Fieser '* first appeared in 1944, but it is already established as a standard textbook for students of organic chemistry. The third edition contains all the essential material of the two previous editions, but much more besides. For, as the authors tell us, the last few years have been rich in new developments and many of these are now included for the first time.

In unskilled hands, descriptive organic chemistry can easily degenerate into a mere recital of facts. But this never happens here. Throughout the book the authors' enthusiasm for their subject is manifest and even the old and well-known facts are enlivened. Thus (page 908) one can almost see Friedländer dissecting 12,000 molluscs to obtain his 1.4 g. of Tyrian purple.

Sections are included on reaction mechanisms, conformational analysis and orbital theory, and though perhaps the last is not treated quite as fully as might have been desired, the reading lists at the end of each chapter give the student a very adequate selection of books and reviews for further study.

The numerous problems, with answers, are useful and well selected. Format, printing and binding are excellent and the reviewer was unable to find any misprints or obvious errors of fact.

This is a book of wide scope, clearly and interestingly written. It covers most of the syllabus of an honours degree course, but will also be useful as a reference book for post-graduate and research workers. It is excellent value for the money.

N. PILPEL

**Organic Chemistry* by L. F. & M. Fieser. Third edition. Chapman & Hall Ltd., London, 1956. Pp. 1150, 50s. net.

BOOKSHOP SERVICE

All books reviewed in CHEMICAL & PROCESS ENGINEERING and all other scientific or technical books may be obtained from:

Technical Books,
308 Euston Road,
London, N.W.1.
Telephone: Euston 5911.

Prompt attention is given to all orders.

Guide for Chemical Plant Users

The British Chemical Plant Manufacturers' Association have issued the 1957 edition of their illustrated directory ' British Chemical Plant.' It has three sections as follows:

(1) List of members with their addresses and, where they have wished to publish them, the names and addresses of their overseas agents.

(2) Illustrated section consisting of members' advertisements.

(3) Classified index of products and services prefaced by advice to enquirers and followed by a key in French, German and Spanish.

A limited number of copies is available free of charge to chemical plant users on application to the secretary of the Association at 14 Suffolk Street, London, S.W.1.

Chemical production flow sheets

A new set of leaflets has been published in the ' Dechema Exchange of Experience ' series which represents a new and enlarged edition of the set of leaflets issued in 1949 entitled ' Construction Flow Sheets, Symbols Used for Equipment,' which has long been out of print.

The set consists of 40 sheets and contains 220 diagrams representing the types of equipment which are most commonly used in chemical technology. The set costs D.M. 16 and is available from Dechema (Deutsche Gesellschaft für chemisches Apparatewesen), Frankfurt am Main 7, Postfach.

INDUSTRY REPORTS . . .

Nickel progress

Availability of more nickel supplies for industry—barring any large increases in defence demands—was forecast by Dr. John F. Thompson, chairman of the International Nickel Company of Canada Ltd., in a year-end review of the nickel industry. He revealed that, after many years of nickel shortage for civilian purposes, the combined supply of market and premium-price nickel came into close balance with demand in nearly all areas of the world during the last part of 1957. In fact, in the largest market, the United States, the supply exceeded the demand.

Despite the fact that production of nickel-containing stainless steels in the United States, owing to reduced defence requirements, will be less than the all-time record established in 1956, the nickel-containing types will account for a greater percentage of the total stainless steel output during 1957 than for any year since 1948. In the United Kingdom, production of wrought, nickel-containing stainless steels showed an increase of almost 10%. The demand for nickel-containing stainless steels continues high in all fields. Greater amounts of these steels are being employed for structural parts in military aircraft and missiles.

The amount of nickel consumed by the steel industries of the United States in the production of nickel-containing engineering alloy steels in 1957 was approximately the same as in 1956. Total alloy steel production was lower than in the previous year, but there was a greater demand for steels containing higher percentages of nickel. During the year, plans were announced in the United Kingdom and other countries for the expansion of facilities to increase steel production and it is expected, therefore, that nickel alloy steel output will increase proportionately.

Principal applications for cupro-nickel alloys with from 10 to 30% nickel were in the marine, petroleum and power industries for heat-exchanger tubes operating under severe conditions, while requirements of nickel for catalytic and chemical applications increased during the year. In Europe, the demand for greater sources of power and heating, coupled with the shortage of indigenous oil, is leading to many developments in gas production in which nickel catalysts are playing an important role.

Copper tube and plate

As we go to press the Yorkshire Copper Works Ltd. is submitting to its shareholders, at an extraordinary general meeting, the proposals to combine the company's activities in the copper and copper-alloy tube and plate industry with those of I.C.I. (see C.P.E., December 1957, page 480). In a statement to shareholders the company's chairman, Mr. G. P. Norton, points to the danger of severe competition from Germany and elsewhere in the event of a European Free-Trade Area being formed, but adds that at the same time major markets at present protected by heavy tariff walls would be opened up provided the company is in a position to compete there.

Mr. Norton points out that I.C.I. hold a similar position to Yorkshire Copper in this field and both companies have a world-wide market in tubes for ships, power stations and oil refineries, and in sugar evaporation tubes.

Desalting mine water

The chairman of the Free State Geduld Mines Ltd. (South Africa) reveals in his statement that the results obtained from the experimental pilot plant for desalting underground mine water, operated in Welkom by the Council for Scientific and Industrial Research in co-operation with mining companies in the Orange Free State, have been sufficiently encouraging to warrant further experiments on the purification of mine water on a far larger scale. Work has recently commenced on the construction of a plant designed to treat 3 million gal./day of water.

Seven other mines in the Orange Free State are participating with Free State Geduld Mines in the capital and operating costs of this experimental plant.

Billingham in 1957

Mr. W. J. V. Ward, chairman of the Billingham Division of Imperial Chemical Industries Ltd., states that the Division was able to keep its plants running at high rates during 1957. In the fertiliser market, more nitrogen was used in Britain than in any previous fertiliser year. Abroad there are large supplies of fertilisers on offer and many plants in the U.S.A. are running well below capacity; however, I.C.I. have sold and shipped large tonnages of ammonium sulphate overseas.

COMPANY NEWS

Dr. D. E. Jones, president of the Electric Reduction Co. of Canada Ltd., phosphorus chemicals producers, visited Great Britain recently to discuss further expansion plans with the parent chemical company, Albright & Wilson Ltd. Electric Reduction recently announced that it was embarking on rapid expansion projects, and work is in progress on a multi-million-dollar expansion of its sodium chlorate plant at Buckingham, Quebec. A large plant for sodium chlorate production was completed early this year in Vancouver to serve the important market in the paper pulp industry of the West.

*

Premier Colloid Mills Ltd., in association with their northern agents, O. O. Robinson (Leeds) Ltd., have recently opened a modern laboratory at Glebe House, Hollin Lane, Leeds 16 (telephone Leeds 54131). Premier Colloid, who produce precision mixers and colloid mills, state that these facilities will be at the disposal of firms in the Midlands and North of England who wish to test their materials or seek technical advice.

*

The annual staff dinner of Huntingdon Heberlein & Co. Ltd. was held in the Trocadero Restaurant, London, recently. Among the guests were Mr. R. B. Potter (chairman), Mr. and Mrs. J. W. Meredith, Mr. and Mrs. Stanley Robson, Mr. J. Woollam and Mr. H. Hinton.

*

Price's (Bromborough) Ltd. announce the appointment of Axel H. Agren A.B., Gothenburg, as the selling agents in Sweden for Price's oleines, stearines, fatty acids and fatty alcohols.

*

For some time past Shell-Mex and B.P. Ltd. have been publishing a series of advertisements featuring leading British industries. Oiling the wheels of industry would scarcely seem to be a matter for comedy, but in the hands of artist Peter Kneebone it can be hilariously funny. These advertisements have now been collected into a coloured booklet 'Oiling the Wheels.'

*

Work has begun on a new chemical building at the Warrington works of Joseph Crosfield & Sons Ltd. This five-storey, £1-million plant will be completed in 1960; in it will be concentrated most of the Crosfield chemical production which is at the moment being carried out over a large area of the 37-acre factory.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

New accessory for infra-red analysis

For use as an accessory for its infra-red analytical instruments, a new pressure cell has been developed by the Instrument Division, Perkin-Elmer Corporation, U.S. The cell, which is available in two standard lengths of 60 mm. and 5 to 10 mm., depending upon the position of cell spacers, is useful in trace analysis and overtone work.

The new cell enables gas and liquid samples to be run at high temperatures. It is rated for use at interval pressures of 200 p.s.i.g. or less and has been tested at pressures of 250 and 300 p.s.i.g.

The cell consists of a stainless-steel body with windows at each end, and are sealed with Kel-F *Elastomer* O-rings. Samples are fed into the cell through two pipe fittings located on its body. Available window materials include potassium bromide, sodium chloride, potassium fluoride, and fused quartz. **CPE 832**

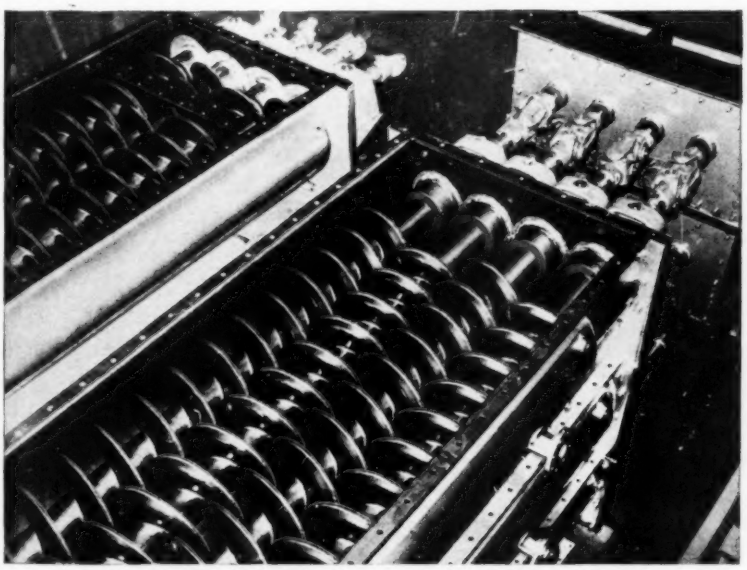
Heat exchanger uses hollow screw conveyor

Combination of a large area of heat exchange with low space requirements is achieved in the *Holo-Flite* processor, now to be manufactured in the United Kingdom and marketed by Holdan Engineers (London) Ltd., Westminster. This heat exchanger is designed as a screw conveyor with helical, hollow flights through which the heat transfer is circulated. It moves the material to be heated, cooled or dried at a uniform, predetermined rate.

Heat is transferred to or from the material being processed by contact with the surfaces of the hollow flights and shaft and, since the principle of the conveyor is employed, the particles of the material within the mass are subjected to continuous movement by the helices and are constantly changing position.

In a 'multi-unit' the material passes through the several units in series and the heat-exchange agent for heat-sensitive materials can be introduced into each unit individually at the desired temperature. In this way shock treatment can be controlled and undesirable chemical reactions avoided. In a continuous operation, by using the required temperature in each unit, the material can be heated or cooled to meet specific requirements.

The *Holo-Flite* can be used in a wide range of applications including the cooling, heating and drying of chemical and other products. **CPE 833**



Picture shows two pairs of hollow helical 'Syncro-Screws.'

Control of water chlorination

A new instrument for measuring the residual chlorine content of water during sterilisation is available in two models, one giving a direct reading in parts per million and also a continuous chart record of the total residual chlorine in the treated water and the other model recording either the total or the free residual chlorine.

In the latter model a reference cell is supplied with a continuous sample of the treated water from a small constant-head tank. Neutral orthotolidine is applied in a mixing chamber to the portion of the water used for residual determination which is passed through a separate measuring cell and eventually to waste. Both cells are illuminated from a single light source by means of mirrors, the light passing through filters to individual photo-

electric cells. The variations in colour induced by the interaction of the reagents with the chlorine in the sample cause the photo-electric cell to operate a differential electronic recorder.

The model recording total residual chlorine only is similar in principle and construction but uses a single photo-electric cell and a simpler means of application of the reagent, which in this model is acid ortho-tolidine, producing a yellow colour in the presence of any type of residual chlorine.

Further information is available from Paterson Engineering Co. Ltd., or by making use of the reply-paid postcard quoting: **CPE 834**

Epoxy paint lengthens drier life

A new approach to the protection of vacuum tray driers is represented by a drier which has had the interior coated with an epoxy resin paint. The model in question, manufactured by Apex Construction Ltd., has the door mounted on a runner rail mechanism.

The epoxy resin paint used was clear *Araldite* 985E. **CPE 835**

Plastic lining of storage tanks without interruption of production

A new technique has been perfected for the lining *in situ* of process and storage tanks with plastic linings of various types. It includes the shot-blasting of the steel or other surface by a vacuum shot-blasting machine which allows no debris or abrasive to be liberated into the atmosphere; the application of a suitable plastic lining (different types are used depending on the actual duty); and the heat-curing of the lining to give a hard, durable, tightly adhering, chemical-resisting and inert film.

One feature of this technique is that it has been found possible in many cases to reline tanks with the minimum of interference with production. For example, it is practicable to reline storage and conditioning tanks in brewery and other cold rooms with a stoved lining where the ambient temperature is at freezing point at all times while carrying out the work.

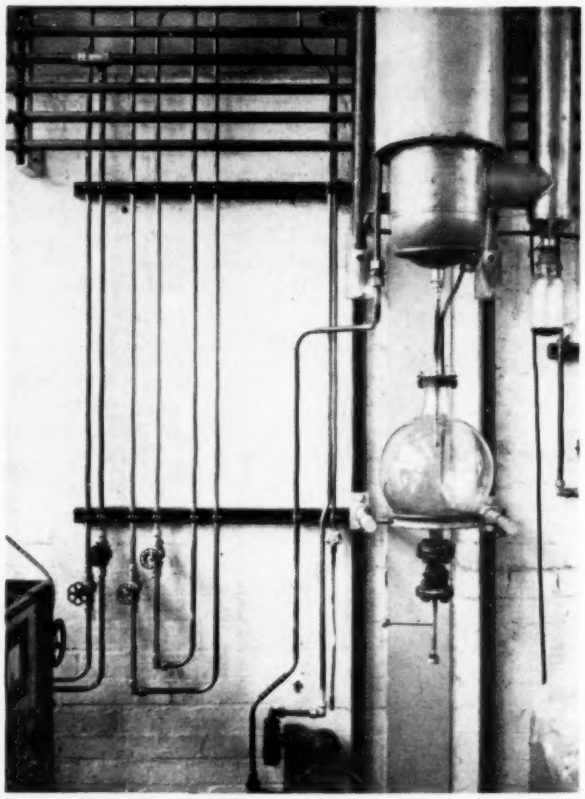
In all cases linings are ' tailor-made ' for the job in hand and further details are available from Corrosion Ltd. or from the CPE Enquiry Bureau quoting: **CPE 836**

Shot-blasting

The new *Major* machine produced by Vacu-Blast Ltd. has been in production for a few months and several of them are now working on a variety of shot blast applications.

The machine is a modified and improved equivalent of the Vacu-Blast *Standard* machine. Different in appearance from the superseded model, it employs assembly parts which are largely interchangeable, and all the attachments for use with the *Standard* can be used with the *Major*.

The machine comprises the essential units of all Vacu-Blast machines—the generator-reclaimer and dust collector, and, in common with the *Senior* machine, these two units may be sited individually at some distance apart or they may be integrated to form a single unit. **CPE 837**



STEEL CHANNEL SYSTEM SOLVES SUPPORT PROBLEMS

Extensive use of Unistrut *steel channel framing system to support a wide variety of installations is being made by Vitamins Ltd. in their rapidly expanding factory at Crawley, Sussex. In the fine chemical manufacturing departments, for example, all the pilot-plant vacuum distillation units have their condensers, glass pipework, and all service pipelines associated with them, supported entirely by* Unistrut *channel.* Unistrut *concrete inserts fixed flush with the walls are used to carry service mains through pipe ducts interconnecting the various chemical production buildings.*

In the chemical production section, the system is used to support service pipes (including glass pipeline), pressure gauges, etc., adjacent to reaction vessels. Unistrut *channel enabled a complex set of pipe runs to be installed on the outside walls of fume chambers so that the services required within the chambers could be controlled without the necessity for entering them.*

The Unistrut *steel channel support system combines box-section strength with rapid on-site assembly, yet allows complete dimensional freedom for the planning of individual support structures. The steel channel sections are connected by a self-locating nut fitted with a spring which positions it inside the channel and, by using one of the full range of fittings, alterations and additions can be effected easily and with minimum disturbance to the existing structure.* **CPE 838**

Automatic alarm panels

Alarm panels which are fully automatic and re-set themselves have a wide range of applications and are particularly useful for preventing overfilling of oil and liquid storage tanks. They are also suitable for use with temperature and pressure control systems, in conjunction with thermostats and pressure-sensitive control mechanisms, respectively.

In a typical application, over-filling of an oil tank results in an audible warning from the alarm bell while at the same time a visual warning is provided by a lamp situated in the face of the panel. By depressing the cancel button in the panel, the bell cuts out but the warning light remains on until the oil level in the tank falls below the high-level position. When the warning light goes out the panel automatically re-sets itself ready for the next filling operation. Makers are Kingston Control Systems Ltd. **CPE 839**

New high-speed centrifuges

Three new centrifuges recently introduced by the Sharples Corporation include:

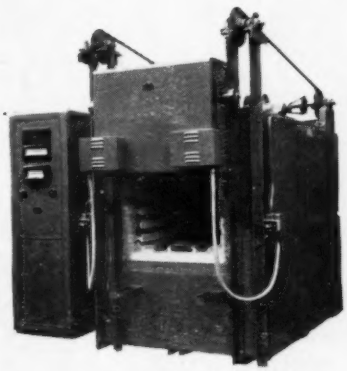
High-capacity vertical decanter-type unit for pressure operation to handle slurry feeds in the range of 200 to 250 gal./min. with solids discharge of up to 10 tons/hr. Called the Sharples P-7000 *Super-D-Canter*, this design includes a pressure-tight model for operation at up to 150 p.s.i., a vapour-tight model for operation at up to 15 p.s.i. and an open model. Unique design features incorporated in the P-7000 are a single set of seals (which are not in contact with the slurry); only one set of main bearings required; and integral mounting of motor on the frame.

High-capacity nozzle-type continuous model, also available for operation under pressures up to 50 p.s.i. and more. Employing a double-row nozzle system and a 30-in.-diam. bowl, the new Sharples DH-6 *Nozljector* provides for efficient clarifying, separating or solids concentration at rates up to 300 gal./min. or more.

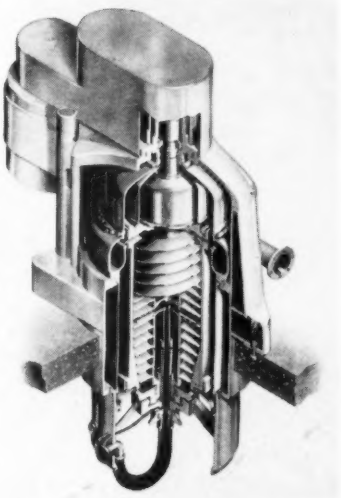
The new bowl design and high-efficiency drive permit full utilisation of up to 125 h.p. The DH-6 is available in pressure-tight, vapour-tight or open designs, and with or without a recycle system for the controlled concentration of solids.

High-speed horizontal decanter-type centrifuge which, owing to its high speed of rotation (4,000 r.p.m.) and longer bowl, offers materially increased throughput capacity and greatly improved clarity in the continuous processing of slurries. Called the P-3000 *Super-D-Canter*, this unit is designed to handle economically large quantities of slurries and suspensions in the removal, recovery and dewatering of solids from slurries and the clarification of liquids. **CPE 840**

Electric fork-lift truck for hazardous areas.



Box furnace with press-button-operated door.



A recently-introduced centrifuge, the P-7000 'Super-D-Canter.'

Heavy-duty box furnaces

Box-type furnaces are available which have many heat-treatment applications, such as vitreous enamelling, annealing, case-hardening, normalising, stress relieving and any other metallurgical process.

In one example given by the makers, Hedin Ltd., features to note are the press-button-operated door, non-distorting hearth and efficient thermal insulation. The heating elements are in heavy section 80-20 nickel-chromium and operate on a low voltage *via* a transformer. Elements are fitted into the door, as well as the walls of the heating chambers, to ensure an even temperature throughout. Automatic temperature control and various safety devices are further features. **CPE 841**

Flameproof fork truck

Built to Buxton requirements, the *Conveyancer* flameproof electric fork truck provides all the advantages of battery electric operation in fire hazard areas. The outer turning radius of 77 in. is only 4 in. greater than the standard model. Ventilation of the battery is based on Ministry of Fuel and Power Test Memorandum No. 11 and Safety in Mines Research Establishment Report No. 122.

External wiring between all electrical components consists of mineral-insulated, copper-clad cables made adaptable to conduit entry by means of screwed flameproof glands which house and protect the sealing termination.

The capacity of this truck is 4,000 lb. at 20-in. load centre and the makers, Conveyancer Fork Trucks Ltd., intimate that a 4,500-lb. version will also be available. **CPE 842**

Industrial gas chromatograph

The continuous monitoring of industrial gas systems is possible with an instrument in which sample gas is continuously bled from a main process stream and led through the instrument's linear sample valve. Periodically, in response to the instrument's internal timing system, the valve transfers the contents of the 'sample loop' to a constant stream of carrier

gas. The sample is flushed through a chromatograph column which, by means of absorptive or adsorptive granules, separates the gas into its component parts, each of which register their passage through a thermistor sensing cell by changing the thermal conductivity of the carrier gas.

A second thermistor cell, measuring pure carrier gas, serves as the second leg of a Wheatstone bridge circuit. Signals from this are transmitted to a strip chart recorder where they are presented either as a spectrum of the entire mixture or as a bar graph of important components.

The instrument is being marketed in the U.K. by Winston Electronics Ltd. **CPE 843**

Electrolytic hygrometer

Another instrument recently introduced to Britain by Winston Electronics is for the continuous or batch measurement of water content down to 1 p.p.m. in gaseous or vapour samples.

Analyses are made by continuously absorbing and electrolysing any and all water present in a sample stream entering the instrument's analysing system. Gas streams of up to 100°C. can be handled. An alarm system can be set for any point in the instrument's range. Either a 10- or 50-mv. standard potentiometric recorder or recorder-controller can be operated from the hygrometer output, making possible the continuous monitoring of water vapour in plant process stream.

High concentrations of water in gases can be measured through use of dilution techniques. Liquid systems may be measured by dry nitrogen stripping. **CPE 844**

Thin-wall PTFE tubing

A newly formed company, Polypenco Ltd., has as its main interest the manufacture of nylon, plastics, etc., and is offering thin-wall PTFE tubing in sizes of $\frac{1}{8}$ to 1 in. i.d. Standard i.d.'s available are $\frac{1}{8}$ in., $\frac{3}{16}$ in., $\frac{1}{4}$ in., $\frac{5}{16}$ in., $\frac{3}{8}$ in., $\frac{7}{16}$ in., $\frac{1}{2}$ in., $\frac{5}{8}$ in., $\frac{3}{4}$ in., $\frac{7}{8}$ in. and 1 in. Nominal wall thickness are .030 in. on sizes through $\frac{5}{8}$ in., .040 in. on $\frac{3}{4}$ in., .045 in. on $\frac{7}{8}$ in. and .050 in. on 1 in. All sizes are available in ten coded colours for circuit or fluid identification.

Suggested uses for the new tubing include chemical and food processing lines to take advantage of PTFE's chemical and heat resistance, as well as its anti-stick properties. As inherent in PTFE, it is odourless, tasteless, non-corrosive, fungus-resistant and has excellent outdoor life. Suitable fittings are being developed to facilitate its use for flow line purposes. **CPE 845**

PVC ball valve

Manufactured from unplasticised rigid PVC, a new ball valve is fitted with a precision ball section which permits full opening of the valve with a 90° turn of the handle. Units are available in sizes from $\frac{1}{2}$ to 2 in. B.S.P. with screwed ends, flanged ends or ends for welding, and suitable for 150 p.s.i. up to 100°F., 100 p.s.i. up to 115°F., or 50 p.s.i. up to 130°F.

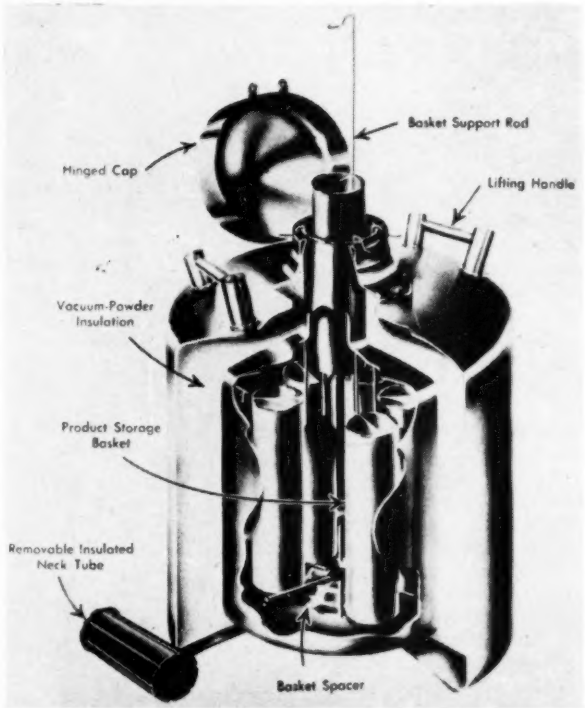
Fluon gaskets provide the liquid-tight fit between ball and body of the valve, and *Fluon* seals are also incorporated in the stuffing box to prevent leakage of liquid at this point. According to the makers, Rediweld Ltd., these valves can be used with all types of inorganic acids; details of resistance to chemicals are also offered. **CPE 846**

Portable refrigerator chills at –320°F.

In the United States a portable liquid-nitrogen refrigerator, for laboratory and practical use in science and industry, has been announced. A double-walled jacket of *Heliarc* welded stainless steel is insulated by a vacuum-powder combination and the inner container is filled with liquid nitrogen having a temperature of –320°F. Accessory storage baskets filled with material for freezing or cold storage are lowered into the liquid nitrogen.

The nitrogen refrigerator will then hold material at a constant temperature of –320°F. as long as liquid nitrogen, in sufficient quantity, is present. A single charge of liquid nitrogen will last to 34 days.

The new unit, produced by the Linde Department, Union Carbide International Co., weighs only 115 lb. fully charged and 60 lb. empty. **CPE 847**



Portable refrigerator.

MICRO HAMMER MILL

For rapidly pulverising such substances as hay, roots, linen or stone into powder, Glen Creston Ltd. are marketing a micro hammer mill. It has been designed to reduce the particle size of small samples to the degree required for analytical work. Its dimensions and construction are aimed at making the crushing, and recovery of the ground product, and subsequent cleaning of the mill, as simple and speedy as possible. The mill is 10 in. high and weighs 10 lb. **CPE 848**

RECENT PUBLICATIONS

Technical chemicals. Up-to-date information on more than 40 technical chemicals in current production by Howards of Ilford Ltd., for the textile, plastics, adhesion and allied trades, is now available in book form. Copies may be obtained from the company at Ilford, Essex.

Dust collectors. Almost every industry is faced with the problems of dust removal from air or gases as a means of the prevention of atmosphere pollution, the salvage of valuable constituents of processing operations, or to fulfil a processing function. Buell Ltd., 3 St. James's Square, London, S.W.1, have recently published an illustrated booklet describing their range of dust collectors.

Paste resin. A technical booklet has been published by British Geon Ltd., Devonshire House, Piccadilly, London, W.1, describing their paste resin, Geon 121. This is a high molecular weight PVC resin which, when mixed with normal proportions of plasticiser, forms pastes of varying viscosity depending on the amount and type of plasticiser used. Such pastes may be processed by a number of techniques to give a wide range of finished products.

Chemicals. Pennsalt Chemicals Corp., 3 Penn Center, Philadelphia 2, Pennsylvania, U.S., have recently produced a 16-page brochure describing the properties and typical applications of more than a hundred inorganic and organic chemicals.

Nickel. The September issue of a bulletin giving current information on nickel includes a table summarising, in ready reference form, the result of researches carried out by the American Electroplaters Society on the effects of impurities in nickel-plating solutions and methods of purification. Work done by the same Society on the physical properties of electro-deposited nickel is the subject of one of the abstracts. Copies of the bulletin are obtainable from the Mond Nickel Co. Ltd., Publicity Department, Thames House, Millbank, London, S.W.1.

Climbing film evaporator. Q.V.F. Ltd., of Fenton, Staffs., have published a brochure entitled 'The Climbing Film Evaporator,' first of a projected series of brochures dealing with standard units of equipment for specialised chemical processes. It illustrates the climbing film evaporator unit with a single 1-in. bore calandria tube, 10-ft. long, suitable for operation either at atmospheric pressure or under vacuum, as a single-pass or recirculation unit.

Expanded rubber. The history of the invention and commercial development of expanded rubber is recorded in a book published by the Expanded Rubber Co. Ltd., of Croydon.

Industrial changes explained. To keep people in industry up to date with technical changes and research, the Department of Scientific and Industrial Research are publishing a new series of publications called 'Problems of Progress in Industry.' The first booklet in the series is 'Men, Steel and Technical Change,' and describes the changes that have taken place in a steelmaking undertaking.

Valves. Audley Engineering Co. Ltd., of Newport, Shropshire, have recently issued two publications. One deals with their power-operated valves and remote control, and the other with their electrically operated valves.

Dust control. A works manager selecting a dust-control plant looks for three or four points, *e.g.*, effective removal—and if the dust is valuable or dangerous, recovery—ease of operation and relatively low installation costs. This is pointed out in an illustrated pamphlet from the Power-Gas Corporation Ltd., Stockton-on-Tees, describing the *Favorit* filter process. The process can be used for the recovery of dust and fume in such industrial processes as non-ferrous smelting and refining, crushing, grinding, screening and milling operations, the manufacture of chemical powders, paint powders, and in drying.

Lead. A special pump for use with acids and other corrosive liquids is featured in the latest issue (No. 4) of the Lead Development Association's publication, while in the field of nuclear energy not only the role of lead as a biological shield is described but also its use to increase the sensitivity of detecting and measuring devices. Copies are available from the Association at 18 Adam Street, London, W.C.2.

Plastics moulding. A new leaflet describes tests which show that it is possible to reduce the cure time on normal phenolic mouldings to one-tenth of that obtained with no preheating. To achieve it an old, low-power type of preheater was replaced with a modern high-power unit which costs no more than the low-power unit. The leaflet is available from Radio Heaters Ltd., Eastheath Avenue, Wokingham.

Aluminium in packaging. The place of aluminium in the field of packaging, the forms available, composition and properties are discussed in an illustrated booklet entitled 'Aluminium in Packaging' costing 10s. 6d. from the Aluminium Development Association of 33 Grosvenor Street, London, W.1.

Quaternary ammonium compounds. The chemical division of Armour & Co. Ltd. have issued a 16-page booklet on their *Arquads*, a series of quaternary ammonium compounds which comprise 12 standard products to suit a variety of applications. Copies are available from the company at G.P.O. Box 250, Lindsey Street, Smithfield, London, E.C.1.

Calcium carbonate in paint. The effects of using treated and untreated precipitated calcium carbonate in the manufacture of paint are described in a booklet from John & E. Sturge Ltd., of Wheeleys Road, Birmingham 15. Three main grades are analysed and compared—the untreated fine-particle-sized *Calopake F*, and *Calofort S* and *Calofort T* in both of which the ultra-fine particles are coated with calcium stearate.

£ s d

CHEMICAL PLANT COSTS

The Chemical Plant Cost Indices for November 1957 are the same as for October, *i.e.*:

Plant Construction Costs: **173.2**

Chemical Plant Equipment Costs: **166.5**

The basis for these indices is June 1949 = 100. In addition to the month-by-month figures, we have published articles and notes on chemical plant costs from time to time, and a guide to these is given in the Annual Index, which was included in our December 1957 issue.

Comments and enquiries concerning these Cost Indices are welcomed and should be addressed to:

The Editor,
CHEMICAL & PROCESS ENGINEERING,
Leonard Hill House,
Eden Street,
London, N.W.1.

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UNITED STATES industry as a whole has been experiencing a slight recession which is reflected in a lower falling-off in production and seems likely to result in decreased expenditure on plant and equipment in 1958.

Some indication of the situation in the chemical, fertiliser, steel, paper, pigments and rayon industries is given by the lower demand for sulphur in 1957, consumption being down about five percentage points from the record 5,780,000 tons consumed in 1956. According to the president of the Freeport Sulphur Co., Mr. L. M. Williams, the total output of sulphur from all U.S. sources amounted to an estimated 6,900,000 tons, compared with 7,820,000 tons in 1956. Frasch sulphur, mined by the Frasch hot-water process from deposits in Louisiana and Texas, alone accounted for 5,500,000 tons, down from the 1956 record of 6,425,000 tons. Of the remainder of the supply, 525,000 tons represented elemental sulphur recovered from gases, 425,000 tons sulphur contained in pyrites, and 450,000 tons sulphur in other forms.

The September reduction in the price of sulphur—some $3/ton, or just over 10%—was the first price change since 1953.

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The nation's largest, but as yet undeveloped, deposit of phosphate rock was inspected recently by state and government officials and executives of Stauffer Chemical Co., Western Phosphates Inc., Mountain Copper Co., Ltd., and San Francisco Chemical Co. It is anticipated that the deposit, which is at Vernal, Utah, and only 19 transmission line miles from Flaming Gorge, may become a major source of phosphorus within the next few years and particularly so when the Flaming Gorge Dam, now under construction, is completed.

San Francisco Chemical Co., jointly owned by Stauffer and Mountain Copper, holds exclusive rights to the huge deposit, which covers some 15,000 acres. Indicated phosphate rock reserves, averaging 21% P_2O_5, approximate 700 million tons.

To render utilisation of the Vernal deposits economical it would be necessary to build a beneficiation plant at the mining site, especially if the rock were to be shipped to customers at distant points. San Francisco Chemical Co. has developed a beneficiation process which will upgrade the ore for either electric furnace or fertiliser use. This process has been utilised at Leefe, Wyoming, and it is anticipated that a substantial tonnage of the Vernal ore will be treated at Leefe in 1958 to prove out the beneficiation process on a full plant-scale basis.

Moreover, if power is available from the Flaming Gorge Dam, it would be feasible to locate electric furnaces at the mining site to create an integrated phosphorus-producing complex.

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The University of Texas has recently completed a survey of potential water re-use in the State during a period from 1956 to 2010 A.D. This reveals that about 90% of the total industrial water demand originates from nine industrial groups, the remaining industries being primarily small concerns or non-water users. The list of the nine major categories includes mining; primary metal products; transportation equipment; stone, clay and glass products; food and kindred products; textile products; paper and allied products; chemicals and allied products, and petroleum and coal products.

In 1954 the chemical industry was discharging about one-third of the total industrial wastes in the project area. By 2010 it will be providing about two-thirds of the total industrial waste flow. The chemical, petroleum and paper industries together provide about 70% of the total industrial wastes. By the end of the survey period they will be discharging more than 80%.

It is especially noteworthy that the total water supply for the project area will increase about five fold, but due to trends in water usage the quantities of reclaimable waste water will lag behind supply growth unless specific efforts are made toward lessening water consuming losses. The total reclaimable waste water available in 1954 was 263 billion gal. (U.S.). It is anticipated that this annual quantity will grow to 1,190 billion gal. by 2010 A.D.

$ $ $

The Shippingport pressurised water reactor, claimed as the 'world's first full-scale central atomic power plant devoted exclusively to civilian purposes' went into operation recently and a series of tests was initiated, after which the power level of the reactor will be gradually increased. At full power, the plant gives about 231,000 kw. of heat and 60,000 kw. of electricity. Although Shippingport will produce enough electricity to supply the needs of an entire medium-size town, its function is largely experimental. The plant was described in CHEMICAL & PROCESS ENGINEERING, 1956, **37** (8), 273-276.

The pressurised-water type of reactor is only one of the five types selected by the Atomic Energy Commission for development, and another big plant which has received a great deal of publicity is the Sodium Reactor Experiment, built for the A.E.C. by Atomics International and recently given its first public showing at Canoga Park, California. The S.R.E. sodium-cooled, graphite-moderated reactor began production

of power, for generating commercially-distributed electricity, in July, 1957. It is designed to generate 20,000 kw. of heat, the plant having a capacity of about 6,500 kw. of electricity.

Another type of nuclear plant which has been used to produce electricity in the U.S.A. is the Experimental Boiling Water Reactor, while a reactor of the acqueous homogeneous type should be in operation soon. A fast breeder reactor, the E.B.R.2, has reached final-design and site-preparation stages, the E.B.R.1 having been brought into operation some time ago.

Several additional power reactor types have since been advanced to a state of technology which has brought them into favour for projects within the U.S. Government's experimental programme. These types include organic moderated, liquid-metal fueled, gas cooled, molten plutonium, and heavy water moderated-natural uranium.

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The average engineering teacher in American colleges and universities earns a salary of $6,634 p.a., according to a recent survey, and to this he adds consulting and other engineering work to bring his total annual earnings to $8,862.

Any impression of prosperity and contentment among America's teachers that these figures might give to European readers is immediately dispelled by the fact that the figures were brought out in connection with a high-priority study aimed at increasing the supply of competent teachers for engineering colleges. The survey, carried out by the American Society for Engineering Education, also reveals that engineering teachers in privately-supported institutions earn more than those in publicly-supported ones.

The general problem among America's colleges and universities is reflected in the fact that about 20% of the Ph.D. recipients at the Massachusetts Institute of Technology go into college teaching; too few undergraduates take up teaching careers. The attractions offered by industry and government are too great by contrast with those offered by teaching institutions. Dr. J. R. Killian, Jr., president of the M.I.T., states in his annual report that the M.I.T. is giving top priority to increasing its faculty salaries.

To complete the picture of money—or the lack of it—as one of the major obstacles to further progress in American technical education, we have the general feeling that not only teachers' salaries but also financial aid to students needs to be increased. In a recent study the conclusion is reached—on somewhat inconclusive statistical evidence—that some 150,000 high-ability students would have gone to college had adequate financial support been offered them.

$ $ $

At the 26th Exposition of Chemical Industries, held in New York in December, there was a larger representation of chemical products and equipment from abroad than at previous exhibitions, and in the midst of the predominant American displays one came across glass heat exchangers and fractionation equipment from Britain and an Italian display of articles moulded in the new *Moplen* polypropylene.

Chemical engineers found much of interest, not only among the more conventional chemical plant but also in rocket and missile developments, and in the metallurgical advances that have been given impetus by research on missiles. Among the newer materials on view was silicon nitride, currently being used in boats and crucibles for refining transistor-grade metals, while a tantalum condenser for corrosive vapours was another interesting exhibit. A notable feature reflecting on trends in the design of chemical processing equipment is the increasing demand for the more familiar alloys in ferrous and non-ferrous metals, and one exhibitor predicted that the chemical process industries will almost double their consumption of aluminium by 1960.

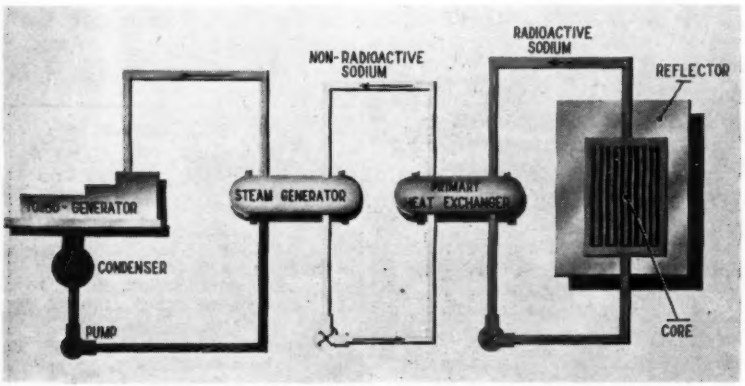
Of timely interest was an exhibit showing the primary separation of uranium from an ore taken at Warwick, N.Y. This was carried out in an up-hill conveyor screen with an air lift to separate the lighter particles. On a Geiger count of 500 the ore showed over 75% U^{308}. A solar furnace, resembling a giant searchlight, was offered for researchers requiring a 'clean heat' up to 8,000°F. obtainable instantly when sunlight is available.

In the field of process control, one interesting exhibit was an instrument which will measure and record changes in viscosity while material is in process, indicating chemical or physical change while it is actually taking place. One application is in measuring the gelatinising properties of starch and starch-containing compounds. Another instrument charts the consistency of pasty and highly-viscous materials during processing, permitting accurate control in the manufacture of artificial resins, PVC powders and plasticisers. It will even determine the softening characteristics of coal during the coking process.

$ $ $

High hopes are placed on the future success of a spongy plastic material, *Curon*, which is claimed to be superior to and cheaper than foam rubber.

The material is at present available only in forms suitable for the clothing industry, carpet padding and household sponges, but the makers, Curtis-Wright Corporation, expect that production will increase rapidly with annual sales running to many millions of dollars p.a.



ELECTRICITY FROM ATOMIC ENERGY IN THE U.S.A.

Artist's sketch showing basic steps in generating electricity from the atomic reactor portion of the Sodium Reactor Experiment, mentioned in the text. Atomic fission in the reactor core produces heat which is carried by radioactive liquid sodium to a heat exchanger. The heat is then transferred to another sodium system which is non-radioactive. Steam produced by the hot sodium drives a conventional turbo-generator. An experimental electrical generating plant has been installed adjacent to the Sodium Reactor Experiment by the Southern California Edison Co.

Personal Paragraphs

★ Among the personalities mentioned in the New Year's Honours List is **Mr. W. J. Worboys,** director of Imperial Chemical Industries Ltd. and vice-president of the Association of British Chemical Manufacturers, who becomes a Knight.

Other awards included the following:

K.C.B. to **Mr. H. W. Melville,** Secretary, Department of Scientific and Industrial Research.

K.B.E. to **Mr. N. A. Gass,** C.B.E., M.C., chairman, British Petroleum Co. Ltd.; **Prof. H. J. Emeleus,** Professor of Inorganic Chemistry, University of Cambridge; and **Mr. C. H. Johnson,** director, Materials and Explosives Research and Development, Ministry of Supply.

O.B.E. to **Mr. S. Alty,** works manager, Brine and Water Works, Alkali Division, I.C.I.

★ Having reached the age of 72, **Mr. K. Wilson,** chairman of Albright & Wilson Ltd., has decided to retire. He became a director of the company in 1910 and has been chairman since 1932. In appreciation of his long and devoted service, the directors have invited him to accept the honorary title of president. He will accordingly retain his long association with the company and will continue to be available for consultation.

Mr. Wilson will be succeeded as chairman of the company by **Mr. S. Barratt,** who joined the company in 1932 and who has been closely associated with the post-war extensions of the Albright & Wilson Group's interests outside the phosphorus field. In 1955 he was appointed managing director of Albright & Wilson Ltd. and earlier this year, when the company's manufacturing assets were transferred to a wholly owned subsidiary company, Mr. Barratt became chairman of the new company, Albright & Wilson (Mfg.) Ltd., whilst remaining managing director of the parent company.

★ **Dr. B. D. Thomas,** scientist and research administrator, has been named to the presidency of Battelle Memorial Institute, U.S., to succeed **Dr. Clyde Williams,** whose retirement as president was announced recently. Dr. Thomas joined the Battelle staff as a research engineer in 1934, was appointed assistant director in 1942 and vice-president in July 1955.

★ **Mr. P. Baines** has been appointed a director of Marchon Products Ltd., and of its associated companies—Solway Chemicals Ltd. and Astoria Shipping & Transport Co. Ltd.

★ **Mr. G. W. Hemy** has been appointed chemical sales director of Joseph Crosfield & Sons Ltd., Warrington, in succession to **Mr. A. C. H. Cairns.**

★ **Dr. J. E. Taylor,** of Joseph Crosfield & Sons Ltd., has been elected a member of the A.B.C.M. Council, and **Mr. M. J. C. Hutton-Wilson,** British

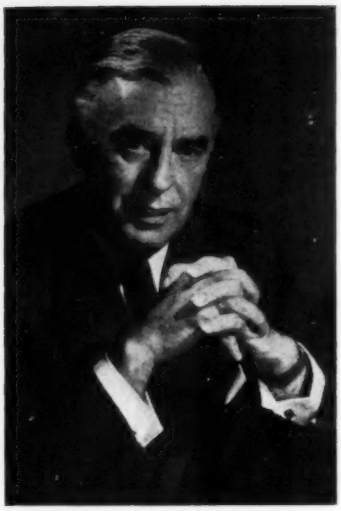
Mr. N. A. Gass.

Chrome & Chemicals Ltd., has been co-opted to fill the vancancy thus created.

★ BTR Industries Ltd. announce that **Dr. W. D. Scott** has been appointed assistant managing director of the company.

★ Appointment of **Mr. H. C. Pitcher** to the position of construction manager has been announced by the M. W. Kellogg Co., New York, a subsidiary of Pullman Inc. Mr. Pitcher will be in charge of all Canadian and South American construction for the M. W. Kellogg subsidiaries: the Canadian Kellogg Co. Ltd., Toronto, and Kellogg Pan-American Corp., New York. He will also be in charge of the construction activities of M. W. Kellogg's fabricated products division.

★ **Mr. R. F. Hayman,** industrial gas officer of the Gas Council, has been appointed chairman of the



Mr. W. J. Worboys.

Industrial Gas Development Committee of the Council in succession to **Mr. W. H. Tarn,** whose term of office as chairman of the Committee has expired.

★ **Mr. J. A. Cochrane,** deputy chairman of James A. Jobling & Co. Ltd., has joined the board of Q.V.F. Ltd. Chairman of Q.V.F., which is a member of the chemical glassware division of the Triplex group of companies, is **Sir Graham Cunningham.**

★ **Mr. A. R. Mathias** has been appointed chairman of the Lead Development Association for the current year, succeeding **Mr. H. L. Evans** who had held this office since January 1956. **Lt.-Col. W. E. Grey** has been reappointed chairman of the Lead Sheet and Pipe Section of the Association.

WRITING A BOOK?

The publishers of CHEMICAL & PROCESS ENGINEERING invite the submission of manuscripts of books to be considered for publication. All manuscripts will be promptly acknowledged and carefully considered by qualified experts. A synopsis with chapter headings should be sent in the first instance to:

The Manager,
Leonard Hill (Books) Ltd.,
Leonard Hill House,
Eden Street,
London, N.W.1

Leonard Hill are specialists in industrial, technical and scientific books. They have a reputation for vigorous and successful promotion of their books by extensive advertising and maintain a world-wide selling and distributing organisation.

World News

NETHERLANDS

Polythene production

At the end of 1958 the Netherlands State Mines will be the first concern in the Benelux countries to start the large-scale production of polythene, to be marketed under the name of *Stamylan*.

Ethylene, the base material, is to be obtained from coke-oven gas. The State Mines have for some time been manufacturing polythene in a pilot plant by the low-pressure (Ziegler) process. Production in the new definitive factory will be by means of the I.C.I. high-pressure process.

The construction of this factory, which will have an annual productive capacity of 7,000 tons, is now in full swing. *Stamylan* will be used for the manufacture of pipes, household goods, packing film, wire and cable sheathing, bottles, etc.

Petroleum expansion plans

The Caltex Petroleum Co. in the Netherlands have stated that they will be doubling the capacity of their refinery, near Rotterdam, during the next few years. Production at the refinery will reach some 100,000 bbl./day by 1960. The development will include the building of a second crude oil distillation plant for petrol and other subsidiary works such as storage tanks.

Nuclear power plant

One of the largest Dutch engineering firms, Stork-Werkspoor of Hengelo, have signed an agreement with Babcock & Wilcox Ltd. for general co-operation in the building of nuclear power plant. Stork-Werkspoor have already contracted to supply some of the equipment for the Dutch high-flux research reactor which is being built at Petten in North Holland.

LEBANON

Superphosphate

A chemical factory under construction at Batroun, North Lebanon, is expected to be in production early this year. It is intended to produce 50 tons of sulphuric acid/day and 4,000 tons of superphosphate/month. It is still uncertain where the phosphate rock will be obtained but Jordan seems to be the most likely source of supply.

DOMINICAN REPUBLIC

Salt refining

A salt refinery has been opened in Ciudad Trujillo to produce iodised salt for domestic use, using salt produced in the mines at Barahona. This plant is stated to be capable of satisfying the entire home market, and will eventually be able to export refined salt to neighbouring countries.

It is claimed that this is the only salt refinery in the Caribbean area and that there are only three salt refineries in South America.

ITALY

Refinery extension

Plans are in hand to increase the capacity of the refinery at Augusta to 2.8 million tons, and to increase storage space to 500,000 cu. m. A new dock, a kilometre long to accommodate super tankers, and a platform in the bay, with the latest oil-handling equipment, are also planned.

Tripolyphosphate

The Italian companies ' Rumianca ' and ' Squibb ' have agreed with the United States company Olin Mathieson to construct near Rome a factory for the production of 30,000 tons of tripolyphosphate p.a.

UNITED STATES

Polythene expansion

A new, high-pressure polythene plant, at Whiting, Indiana, with a rated annual capacity of 72 million lb., will raise Union Carbide's total rated annual production capacity to more than 375 million lb. The new plant, which raises the total of Union Carbide plants involved in the production and compounding of Union Carbide polythene resins to nine, will be completed in the first half of 1959.

INDIA

Monazite reserves

A survey of monazite reserves has been undertaken by the Indian Atomic Energy Department. Reserves of thorium, obtainable from monazite and a possible fission metal of the near future, are estimated to be some 250,000 tons. India's reserves of monazite have been provisionally estimated at over 2 million tons. It has also been calculated that the reserves would yield over 400,000 tons of combined oxides of rare metals group.

Petroleum refining

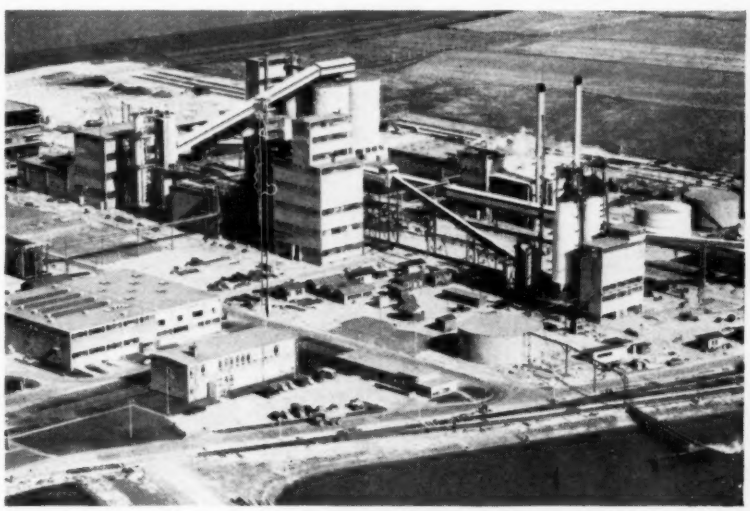
India's third oil refinery has been inaugurated at Visakhapatnam. It cost Rs. 150 million and was built by Caltex.

The other two refineries are in Bombay.

ISRAEL

Chemical exports

The Israeli firm of Fertiliser & Chemicals has resumed exports of potassium sulphate and sulphuric acid. The firm discontinued the export of these chemicals about two years ago when its entire output was taken up



SODA ASH PRODUCTION IN HOLLAND

Aerial view of the new soda ash plant at Delfzijl, Holland, mentioned in our January issue (page 3). The normal ammonia process is applied in this plant. An electrolysis plant, in which mercury cells will be used, is being constructed adjacent to the soda ash plant and is scheduled to go on stream next spring.

by its own plant for fertiliser production. But increased output since makes exports possible again and agreements have been concluded for the shipments of 6,300 tons of potassium sulphate and 6,000 tons of sulphuric acid.

PORTUGAL

Fertiliser production

The Government have allotted 135 million escudos for the manufacture of nitro-ammoniacal fertilisers. Two factories are to be working by 1959 to produce 80,000 tons p.a. of nitrogenous fertilisers, as well as supplying gas for domestic use in Lisbon. The Uniao Fabril de Azoto, in its annual report for 1956, emphasised the need for the establishment of ammonium nitrate manufacture if the Portuguese market for fertilisers is to be satisfied by home production. In 1956 total fertiliser production in Portugal reached 104,000 tons and consumption was about double this figure.

CEYLON

Fertiliser factory

Ceylon's Co-operative Wholesale Establishment has announced its intento establish a factory for the processing and preparation of artificial manure. It is hoped that the products will be marketed for at least Rs. 20 less than the present average fertiliser price of R.S. 330/ton.

KOREA

New cement plant

The cement plant at Mungyong, in Kyongsang Pukto province, built by the United Nations Korean Reconstruction Agency, was formally opened recently. The plant, constructed at a cost of about U.S. $9 million and Hwan 2,300 million, has an annual capacity of 200,000 m. tons.

"SO PERHAPS YOU'LL EXPLAIN SIMPLY TO THESE GENTLEMEN HERE HOW IT ALL WORKS, WILKINSON"

MEETINGS

Institution of Chemical Engineers

February 18. Symposium on tools of chemical production management, 3 p.m., College of Science and Technology, Manchester.

February 25. 'Ion Exchange as a Unit Operation,' by R. Kressman, 7 p.m., Birkenhead Technical College, Birkenhead.

March 4. 'A Contribution to the Theory and Practice of Granulation,' by Prof. D. M. Newitt and J. M. Conway-Jones. 'Gas Liquid Contacting in Agitated Vessels,' by P. H. Calderbank. 'The Design of a Simple Mixer Settler: a Method of Design, by Calculation, Giving Automatic Interface Control,' by J. A. Williams, L. Lowes, and M. C. Tanner. 'Heat and Mass Transfer Accompanying the Absorption of Ammonia in Water,' by G. C. Haselden and S. A. Malaty. Whole day, Church House, London, S.W.1.

March 5. 'The Flow of Granular Materials Through Orifices,' by R. L. Brown, 6.30 p.m., The Midland Institute, Paradise Street, Birmingham.

Graduates and Students' Section

February 19. 'Instrumentation of Modern Chemical Plant,' by A. H. Isaacs, 6.30 p.m., The University, Edgbaston, Birmingham.

February 28. 'Project Cost Estimation,' by E. A. Stallworthy, 6.30 p.m., Caxton Hall, Westminster, London, S.W.1.

March 6. 'Economic Aspect of Scale-up,' by R. G. Dickerson, 7 p.m., Loughborough College of Technology.

The Chemical Society

February 10. 'The Physical Chemistry of Detonation,' by Dr. T. L. Cottrell, 5 p.m., University Chemical Laboratory, Lensfield Road, Cambridge.

February 10. 'High-pressure Chemistry,' by Prof. D. M. Newitt, 6.30 p.m., Chemistry Lecture Theatre, Leeds University. Royal Institute of Chemistry meeting.

February 18. 'Mobility of Adsorbed Molecules,' by Prof. R. M. Barrer, 4.45 p.m., Chemistry Theatre, Nottingham University. Joint meeting with the University of Nottingham Chemical Society.

March 7. 'Uses of Radioactive Materials in Industry,' by Dr. H. Seligman, 5.30 p.m., Chemistry Department, King's College, Newcastle upon Tyne.

Society of Chemical Industry

Road and Building Materials Group

February 20. 'Direct Observation of High-temperature Processes with the Microscope,' by J. H. Welch, 6 p.m., 14 Belgrave Square, London, S.W.1.

Incorporated Plant Engineers

February 27. 'Atmospheric Pollution in Industry,' by W. Herring, 7.30 p.m., Grand Hotel, Sheffield.

Institution of the Rubber Industry

February 10. 'Some Practical Aspects of Latex Foam Manufacture,' by N. Grimshaw, 6 p.m., Newton Heath Technical College, Manchester.

February 10. 'Butadiene and its Co-polymers,' by N. D. MacLeod, 7.30 p.m., Wyndham Hotel, Bridgend.

February 17. 'Recent Advances in Rubber and Plastics Machinery,' by K. M. Wilson, 7.15 p.m., Exchange Hotel, Liverpool.

The Leonard Hill Technical Group—February

Articles appearing in some of our associate journals this month include:

Corrosion Technology — High-temperature Hydrogen Sulphide Corrosion in Commercial Sovaformer Units, 2; Chemical and Electrochemical Affinities of Corrosion Processes.

Paint Manufacture—How the Paint Industry Handles Materials; Influence of Organic Titanates on the Properties of Paints; Styrenated Epoxy Esters.

Manufacturing Chemist—Germicidal Ampholytic Surface Active Agents; A Study of the Behaviour of a Commercial Anti-odorant in Respect of Four Odorous Irritants.

Automation Progress—Continuous Manufacture of Roller Bearings; Russian Work on Translation by Computer; Pointers to Automation in the U.S.S.R.; Automatic Control of Electroplating.

Petroleum—Strength of Welds in Carbon Steel; The Petrochemical Industry.

Dairy Engineering—Reclamation of Bottle Washing Detergents; Dairy Maintenance; Cleaning in the Dairy; New Life for Old Bottles.

Food Manufacture—Review of Canning Equipment; Quick-freezing Developments; Annual Review of Fruit and Vegetables; Perspectives in Malt Vinegar Brewing.

Atomics—Dresden Nuclear Power Station; Electromagnetic Pumping of Liquid Metals; Review of Pumps and Fans.